



The Blast Furnace and Steel Plant

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The Blast Furnace *and* Steel Plant

Vol. XI

PITTSBURGH, PA., DECEMBER, 1923

No. 12

The Potential South

Roger W. Babson says: "Alabama may become the greatest industrial state in America, and Florida may become the greatest agricultural state. The industrial South is no longer dependent upon cotton mills. Immense iron and steel plants, great chemical plants, mills and factories are springing up every day."

A summary of Southern progress since 1910 shows startling changes:

A Summary of Southern Progress Since 1910§

	1910	1920
Population	32,480,343	36,306,855
Density	34.3	38.4
Manufactures:		
Capital	\$2,885,927,698*	\$6,885,546,000
Products	\$3,158,388,799*	\$9,808,114,000
Mines, Quarries and Wells:		
Capital	\$657,011,924*	\$2,274,509,653*
Products	\$213,540,100*	\$1,127,574,868*
Cotton Mills:		
Capital	\$361,000,000*	\$837,870,646*
Spindles, active	11,149,465	15,653,440
Looms, active	236,845	292,132
Cotton used, lbs.	1,121,960,467	1,508,220,261
Cotton-Oil Mills:		
Number	817*	697*
Capital	\$91,086,000*	\$181,888,099*
Pig-Iron made, tons	3,447,291	4,401,583
Coke made, tons	8,966,959	8,439,000
Lumber cut, feet	21,235,437,000	16,648,614,000
Farm Products, value	\$3,915,000,000*	\$9,365,000,000
Cotton Crop:		
Bales	11,599,000	12,787,000
Value, without seed	\$809,030,000	\$874,540,000
Grain Products, bushel:		
Corn	1,104,042,000	1,170,225,000
Wheat	113,992,000	145,880,000
Oats	143,810,000	222,707,000
Live-Stock:		
Cattle	22,010,000	22,205,000
Sheep	9,006,000	6,690,000
Swine	22,814,000	22,358,000
Mineral products, value	\$369,678,060	\$2,285,835,000‡
Coal mined, tons	120,856,340	169,957,000
Iron Ore mined, tons	7,002,340	6,822,892
Petroleum, barrels	79,993,639	254,239,600
Phosphate mined, tons	2,650,000	4,048,000
Railroad mileage	85,739	91,169
Exports, value	\$628,487,700	\$2,695,293,300
Imports, value	\$128,735,700	\$525,567,400
National Banks:†		
Resources	\$1,830,095,231	\$4,678,187,000
Capital	\$225,698,230	\$307,376,000
Deposits	\$899,203,608	\$2,666,313,000
Other Banks, deposits	\$1,056,732,000	\$3,447,151,000
Common Schools:		
Expenditures	\$65,150,000¶	\$204,225,100
Property, true value	\$26,800,000,000	\$70,000,000,000‡

*Census figures deal with previous year. †Includes Island Possessions. ‡Estimated. ¶1908.
§From Manufacturers' Record.

"National Enamel" Problem Demands Uninterrupted Control of Elements

Twelve Different Low-Carbon Steels with 50 Different Finishes in 3,600 Different Specifications Require Unusual Facilities

By F. J. CROLIUS

PART III

FROM the very inception of this great organization, it was apparent that many of the difficulties which always accompany the production of steel must be overcome only by or through the possession or control of every important element entering in the manufacturing phases.

Small sheet producers suffer from an inadequate supply of sheet-bar; sheet-bar manufacturers are dependent upon careful open hearth operations and metallurgical supervision. Open hearth furnace men encounter natural difficulties enough when iron and scrap supplies are practically uniform and in plentiful supply at the moment of charging. Blast furnace success is closely related to the uniformity and combustibility of their coke.

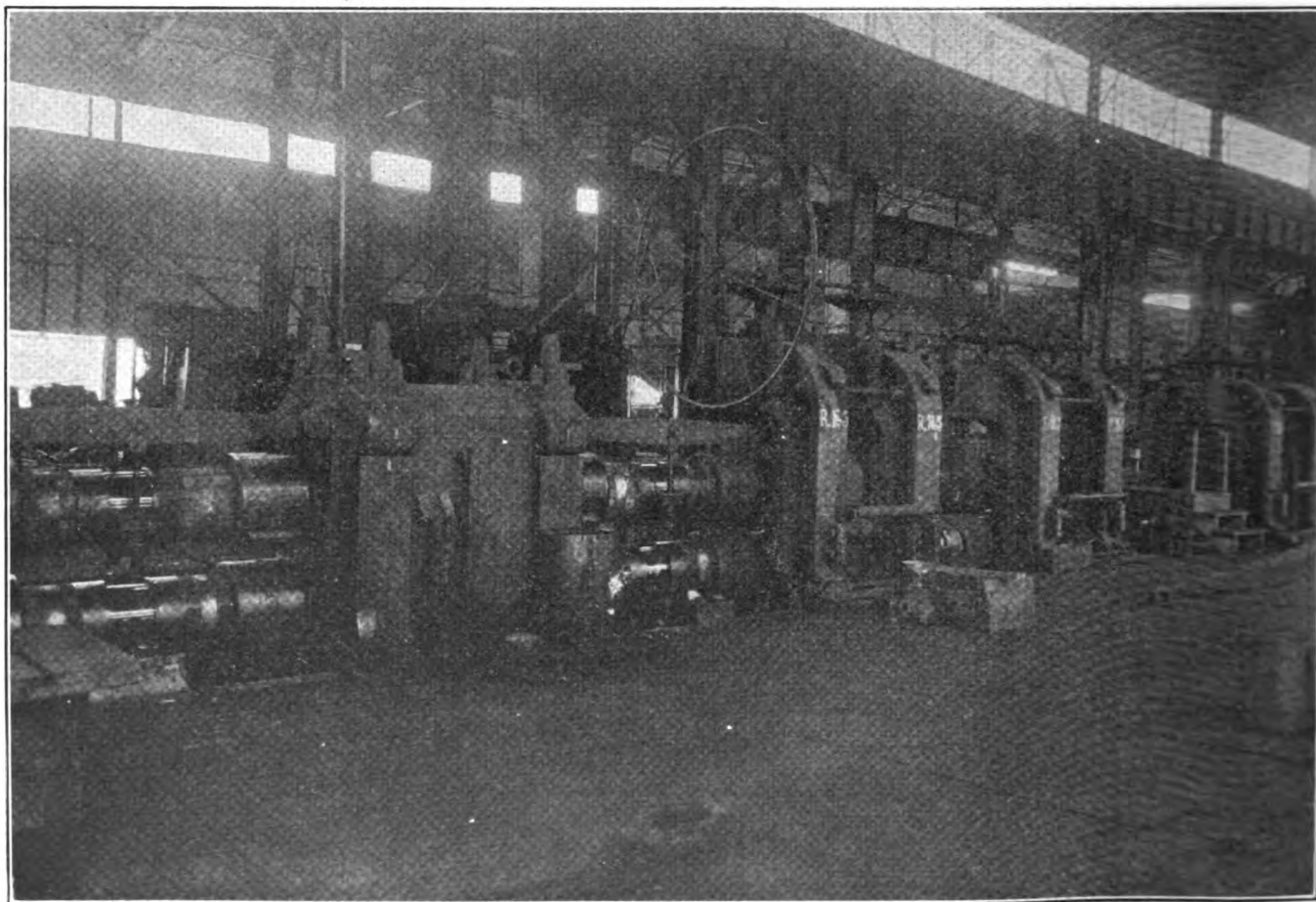
Interrupt any one or several of these steps in the continuity of the production schedule, and the difficulties of guarantee of a quality tonnage are magnified many times over.

In the final analysis, it comes down to a question of competition, and the best equipment, fortified at every stage by close scrutiny by experts answerable to the same organization—operated without the interminable delays and intermediate losses, must always win.

In October and November we described the production of Missouri iron ore, the coking of Illinois coal, their reduction through a most modern blast furnace into molten iron, which is conveyed directly to the open hearth furnaces.

Fig. 13 pictured the new 100-in. plate mill, Fig. 15 the new bar mill, and Fig. 19 the 34-in. blooming mill. The 34-in. universal plate mill and other mills, with the group of sheet and tin mills shown in Fig. 16 were mentioned.

In January will be shown the new and most modern sheet mills, just put in operation, shown in figure below.



Interior view of most modern sheet mill at Granite City.

There are 20 tin mills, driven by two 30-in. x 56-in. x 60-in. twin-tandem compound engines—each driving 10 mills.

One 32-in. x 60-in. Corliss engine driving,—
One roughing and two finishing sheet mills;
One 36-in. x 48-in. Corliss engine driving,—
One roughing and two finishing sheet mills; and
One 28-in. x 48-in. Corliss engine driving,—
Fourteen cold-roll mills.

The aggregate output of these combined mills totals nearly 500,000 tons of finished steel per year, made up into ingots, ship plates, Universal plates, tin plate, black and galvanized sheets, also blue annealed sheets.

Conspicuous among the interesting phases of this interesting plant is the power-house; largely because it is primarily a waste recovery unit.

Fig. 20 shows the interior of this mixed pressure turbine plant; designed and constructed under supervision of the Engineering Service Corporation of St. Louis.

This plant has been erected for the purpose of utilizing the exhaust steam from the mill engines to produce electrical energy for use throughout the plant.

Following is a brief description of the principal features of this installation.

Steam Supply.

The low pressure steam consists of the exhaust from three 36-in. x 48-in. twin engines operating Universal mills No. 1 and 2 and Plate Mill No. 1 and from the hydraulic pumps. Provision is also made inside the power house to utilize the exhaust from the auxiliaries.

The low pressure steam lines from the engines to the power house are installed underground and consist of 16 and 20-in. wrought iron pipe insulated with 5-in. sectional wood casing.

An ample receiver has been provided at each engine with an atmospheric relief line equipped with a relief valve set at about five pounds.

The high pressure steam required for the plant is supplied from the main boiler plant through a 10-in. overhead line installed on steel supports.

Regenerators.

The low pressure steam is delivered from the underground lines into two regenerators located at the end of the turbine plant.

These regenerators are each 9 ft. in diameter by 50 ft. long.

Their function is to smooth out the fluctuations in steam supply from the mill engines and furnish a continuous supply to the turbine.

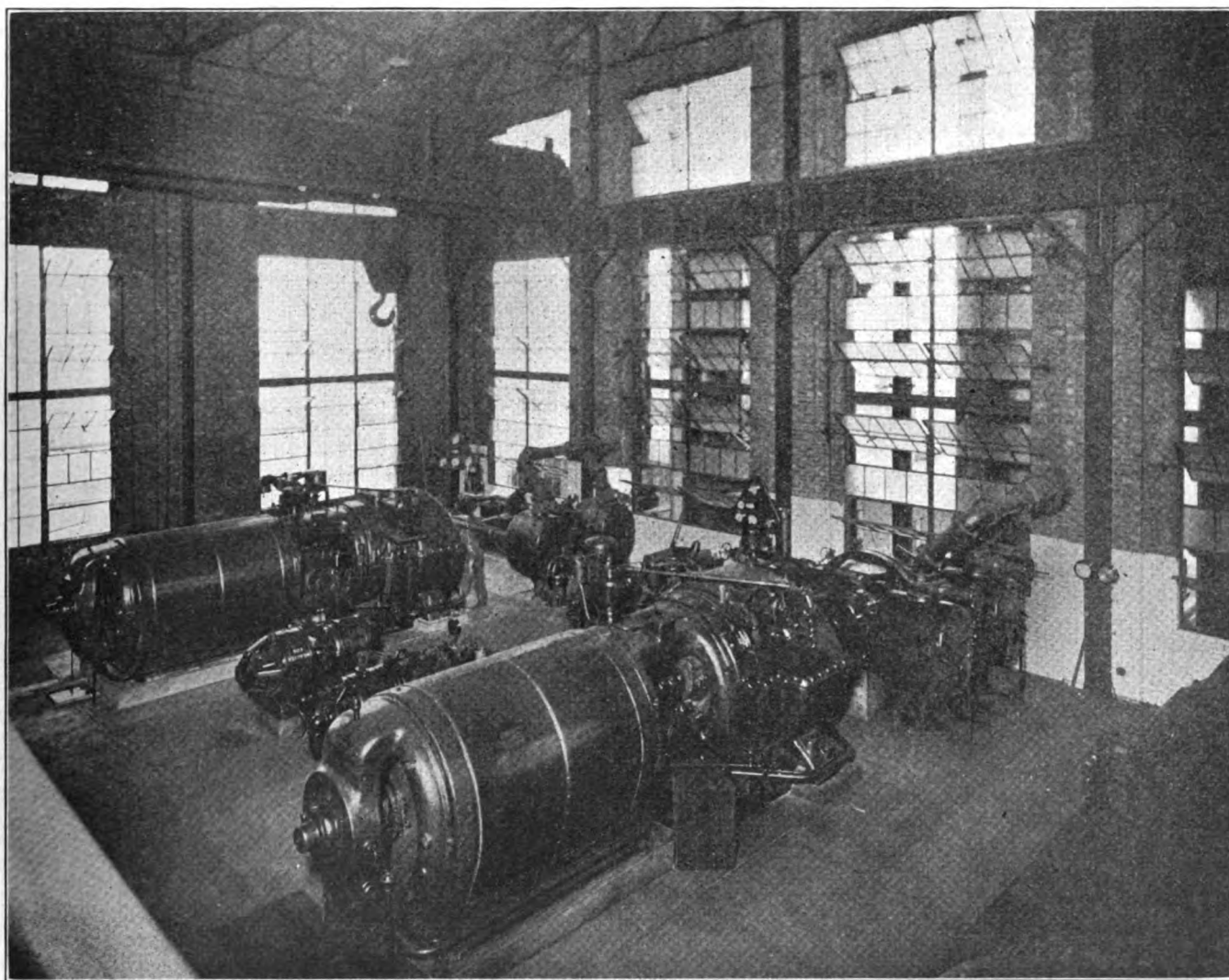


FIG. 20—A view of the interior of the power house—showing the two mixed pressure steam turbines.

From the regenerators the steam is carried to the turbines through a 30-in. header.

Turbo Generators.

The turbines are 2-3,000-k.w. (.80 P. F.) mixed pressure units operating at 3,600 rpm.

They may be operated on either high or low pressure steam exclusively or as mixed pressure units.

When operating as a high pressure unit they have a guaranteed full load water rate of 16.8 lbs. per kwh.

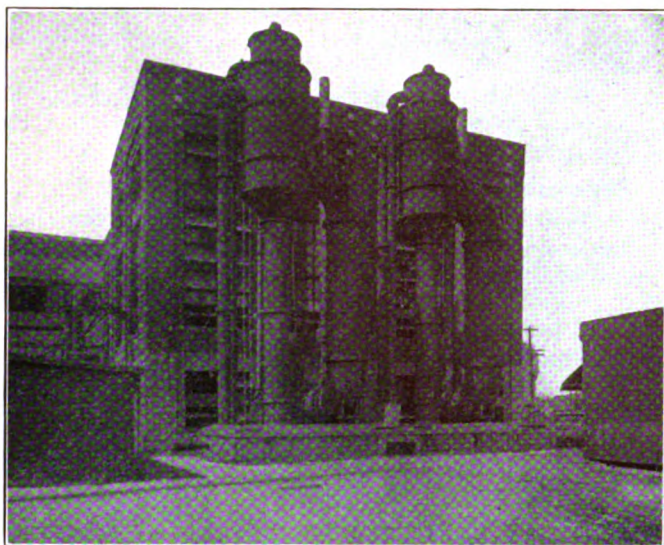


FIG. 21—Condenser end of the power house.

with 150 lbs. dry steam at the throttle and a vacuum of 28 inches absolute. This feature is worthy of note, as it permits of economical generation with high pressure steam during periods when the mill engines are not in operation.

The generators are designed for 3-phase, 2300-volt, 60 cycles.

The air ducts for cooling air to the generator are arranged so that the air may be drawn in from out doors and discharged out doors if desired. Dampers are provided, however, so that part of all of the air may be taken in or discharged inside the plant during the winter months. An air washer is installed in the inlet duct.

Condenser and Auxiliaries.

The condensing equipment consists of cast iron barometric condensers, shown in Fig. 21, located outside the building and connected to the turbines by a 66-in. exhaust pipe; steam driven dry vacuum pumps and two turbine driven geared centrifugal circulating pumps.

One of these pumps handles the water from the basin of the cooling pond to the condensers and the other from the condenser hot well through the spray cooling equipment.

The condensing water is cooled by means of spray cooling equipment, shown in Fig. 23, with a capacity of 10,000 gallons per minute which is installed over a concrete basin which also serves as a reserve storage reservoir.

Excitation.

Excitation for the turbo generators is supplied by a

35 kw. steam turbine driven exciter or a 50 kw. induction motor generator set.

250 Volt D. C. Service.

At the present time all the electrical power used in the mill, with the exception of the Lime Plant which is just being started up, is 250 volt d.c.

For this load two 1,000 kw. synchronous motor generator sets have been installed in the power house, the excitation being supplied by direct connected exciters.

High Tension Switchboard and Control Equipment.

The high tension switchboard equipment is installed on the ground floor in a room entirely closed off from the balance of the plant.

The generator and circuit oil switches are solenoid operated and mounted in individual cells. Instrument transformers are also mounted in cells. The high tension buses and disconnecting switches are mounted on pipe frame work over the cell structure and provided with necessary barriers. The bus layout provides for an ultimate "ring bus" although at the present time only the first section and part of the second section are installed. Provision, however, has been made in bus and cell structure for the bus section switches, disconnects, etc.

To provide for inspection and repairs of oil switches while the plant is in operation a spare oil switch and transfer bus has been installed which may be cut in place of any other oil switch by means of double-throw disconnects. The control for any circuit may be transferred to the spare switch by means of a double-throw knife switch on the main panel board.

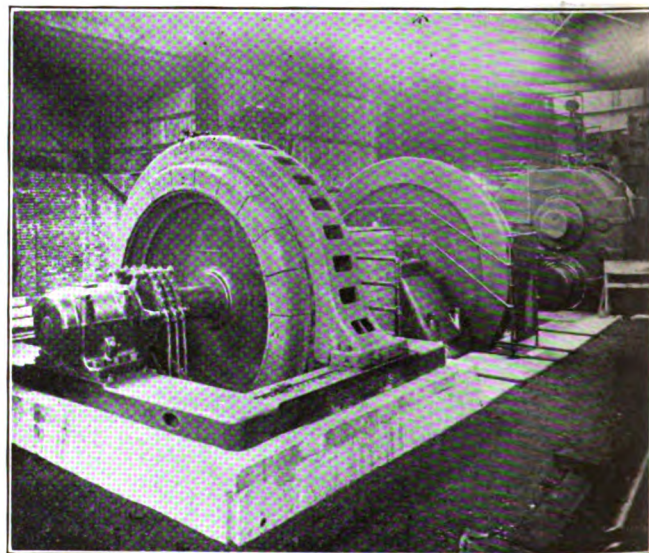


FIG. 22—Motor end of new 100-in. plate mill showing flywheel and United reduction gear.

The compensators and solenoid operated oil switches for operating the synchronous motors are located at the end of the main cell structure.

125 Volt Exciter Control Equipment.

The switches for control of excitation are located on a slate panel board in the same room with the high tension switching equipment and are all solenoid operated remote control carbon break switches, controlled from the main board.

The exciter bus is in two sections with tie switch between. One section handles the two main exciters and turbo generator field, and the other the direct connected exciters on the synchronous motor fields. One automatic regulator has been provided for operation in connection with the main exciters for voltage regulation on the main unit, and another for power factor correction on the synchronous motors. All exciter and generator field rheostats are solenoid operated and are mounted above the exciter board.

250 Volt Direct Current Switching Equipment.

The switches for control of the 1,000 kw., d.c. generators and the outgoing 250 volt circuits are located on a panel board in the switch room on the ground floor. The generators have solenoid operated carbon breakers on the positives and knife switches on negative and equalizers. The outgoing circuits are also equipped with solenoid breakers on the positive and knife switches on the negative.

Operating Board.

The main operating board consists of 12 slate panels located on the main turbine room floor.

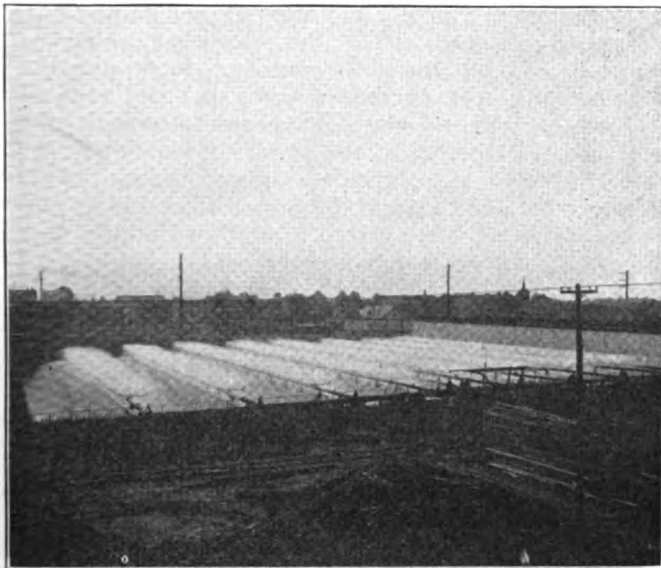


FIG. 23—A fine view of the spray-pond which ensures excellent operating conditions for the condensers.

It is equipped with a full complement of indicating and integrating instruments which will enable the operator to keep a complete log of operations.

The necessary controls for oil switches, field switches, rheostats, etc., are conveniently arranged and a "Mimic Bus" is provided across the entire board by means of which the operator may at all times have before him an indication of the positions of all oil switches and disconnects.

Current for operating solenoids, etc., is provided normally, by a small motor generator set located on the turbine floor, and a storage battery installed on the gallery over the operating board.

Switches are provided so that the control may be thrown on to the exciter bus if desired.

Building.

The turbine plant building is of concrete construction up to the main turbine operating floor with superstructure of steel frame work and brick curtain

walls. The windows are equipped with steel sash, glazed with wire glass.

The roof consists of hollow reinforced cement tile with four inches of cinders on top with a regulation water proof roof covering.

This construction was adopted in order to guard against trouble from condensation.

Space has been provided at the end of the plant for



FIG. 24—An interior of the sheet annealing department showing the freedom from congestion.

extension of the building should additional units be required in the future.

A. C. Distribution.

As stated above the only a.c. load at the present time is at the lime burning plant so that only one a.c. feeder has been installed. This consists of a three conductor, varnished cambric insulated, lead covered cable installed in fibre conduit. This cable is brought out of the underground at some distance from the plant and connected to an overhead line running to the lime plant.

Switching and control equipment for additional a.c. circuits have been provided, and the feeders will be



FIG. 25—A suggestion of the good shipping facilities enjoyed. Broad gauge cars are loaded inside the mill building.

installed as required. It is proposed to install all these high tension feeders underground in order to eliminate the danger of overhead distribution.

250 Volt D. C. Distribution.

When only one turbine was installed it was decided to hold the old Corliss engine station as a stand-by, and it was therefore necessary to install a tie line between the two plants. This tie line has been installed entirely underground and consists of varnished cambric insulated, lead covered cables in fibre conduit.

This arrangement permits the installation of a minimum amount of copper in the tie line without impairing the flexibility of operation in any way.

Heavy Alternating Current Busses for Furnaces and Synchronous Converters

A Practical Discussion of the Difficulties Encountered Due to Magnetic Effects in Carrying Heavy Alternating Current Short Distances in Industrial Plants

By J. L. McK. YARDLEY*

PART II

IN somewhat smaller installations it is practical, where on account of a long run, it is necessary to interlace, to form the star or delta connections at the transformer and to interlace the three phases from that point. With the usual short lengths of run of low tension bus bars, transposition of the bus bars is not necessary. However, transposition would be desirable, if practicable; for, with three separated phase groups of bars in one run, the two outer groups will have greater inductance than the center group. It is generally not necessary to employ transposition in the flexible cables for currents up to 20,000 amperes, at 60 cycles, and 40,000 amperes or more, at 25 cycles.

In fact, the flexibles in photo of Fig. 10 are not transposed though they carry 30,000 amperes at 60 cycles; but the run here is very short. The practical aim of transposition is, of course, to have each cable or strap kept in the same average relative position as every other cable or strap over the run; and if this condition is secured, then each will take an equal current. Figure No. 5 shows a simple case with two cables transposed at middle of run. Fig. 9 shows a more difficult and complicated construction, in which the cables form a hollow cylinder, each cable making a complete turn between start and finish. In this way each cable maintains the same average relative position as every other cable and hence has the same impedance and must carry equal current. The construction is relatively less flexible mechanically, however.

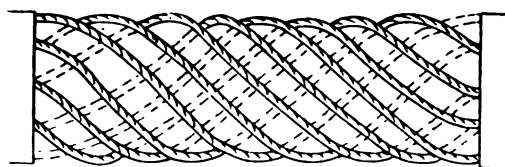


FIG. 9.

For discussion, demonstrating the working out of a comparatively simple electric furnace problem and indicating the various general factors which require consideration let a furnace installation be assumed to operate at 100 volts, 25 cycles, the conductor arrangement and service to be such that a power factor of 90 per cent is obtained at rated full load current.

By referring to the right-angle triangle, Fig. 4, in which 100 volts, the hypotenuse, represents the applied voltage, and 90 volts, the base, represents the component of voltage in phase with the current, the resultant reactance component is found to be 43 volts. With this same furnace operating on 60 cycles for the same current value, the reactance component will be

proportional to the frequency, or equal to 103 volts, which value is more than the impressed voltage. This means that the furnace, even with the electrodes short circuited, would not quite take full load current from a 60-cycle supply circuit. On 25 cycles with the electrodes short circuited, the maximum current that will flow is somewhat less than $2\frac{1}{2}$ times full load current.

With a furnace circuit of constant reactance and varying resistance, the maximum power input occurs when the reactance drop is equal to the resistance drop, or when the power factor is 71 per cent. With the furnace assumed above, this condition would be reached by moving the electrodes and decreasing the resistance until the current reaches 165 per cent of full load current. Under this condition with the power factor 71 per cent, the energy input is 130 per cent of the full load condition assumed above. This is then the maximum amount of power that can be put into the furnace when operating at 100 volts. Further reduction of the resistance and increase of the current would result in such a low power factor that the energy input would decrease below that secured at 71 per cent power factor.

However, where a power factor of 71 per cent is obtained from a furnace load, it means that the capacity of the electrical equipment must be 141 per cent of that required for supplying the true power component of the load. From the standpoint of the Central Station, this will not be as satisfactory a load as one with a power factor around 90 per cent, nor does the furnace operator care to purchase equipment 41 per cent in excess of his needs and of useless reactive capacity. On the other hand the arc furnace requires a certain amount of reactance in its circuit, which serves to store energy momentarily and return it to the circuit during the period of the cycle when the alternating current passes through zero value. In general approximately 30 per cent reactance, corresponding to 95 per cent power factor, must be inherent to the electric arc furnace current in order to stabilize its operation. From an electrical standpoint, therefore, the arc furnace should always operate between approximately the limits of 71 per cent and 85 per cent power factor and commercial furnaces of all types usually do operate within this range.

The capacity of electrical equipment is influenced by power factor and alternating current machinery is rated according to the product of the volts and amperes (kilovolt-amperes) which takes into account the limiting values of capacity as imposed by the current and its attendant heating effect. This is true not only of the generating machinery, but also of the transformers. The heating effect of the current is proportional to the square of its value so that as power

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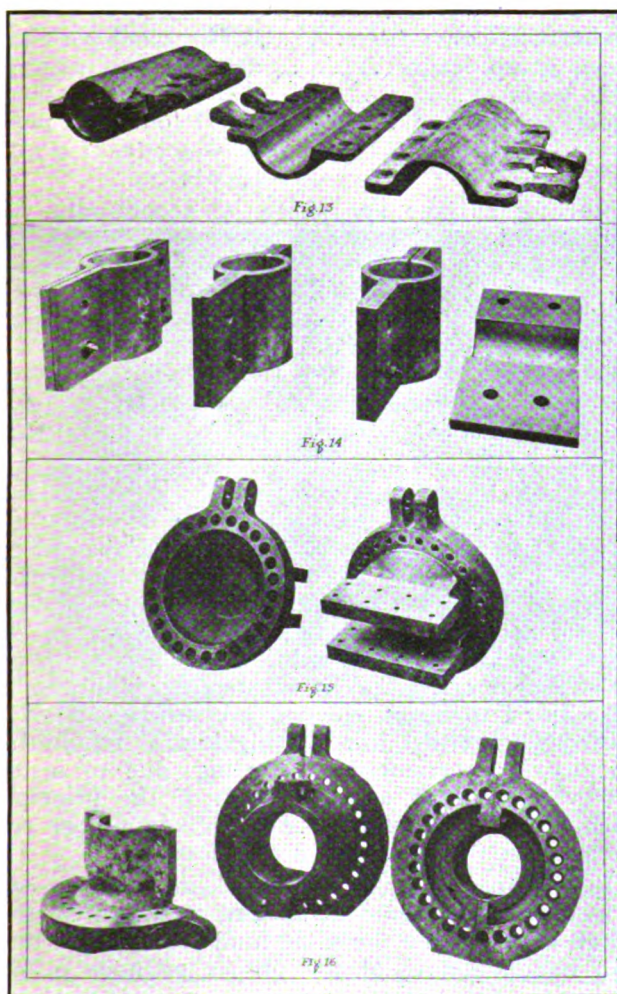
factor decreases, losses due to current flowing through the conductors will increase rapidly. Evidently, it is an advantage to the surface operator to secure a transformer of minimum kva. rating which will perform the service. The lower the reactance of the circuit, the higher will be the power factor, the lower will be the first cost of the transformer and the conductor losses. Because of these factors, too much care cannot be taken in planning a heavy current bus layout in order to secure low reactance and a high power factor.

The efficiency of a heavy current conductor system is, in importance, on a par with that of the efficiency of the transformer and line from which the power is obtained. Accordingly, the question of loss in the heavy conductor system must be viewed in the same way as the loss in the other parts of the system. The importance of these factors will determine the expenditures necessary to reduce the losses.

The weight of conductors for heavy current is an important factor and ample provision must be made for their support. Besides having mechanical strength, these supports must be insulators, although the potentials involved will not usually be in excess of 100 volts. The necessity for laminating and interlacing the conductors in heavy current work complicates the support problem. The contacts and connections

between different parts of the circuit and the terminals of the apparatus carrying the heavy current must also be laid out with the greatest care.

The discussion is carried further and the effect of the electrical phenomena mentioned visualized to a greater extent in the analysis of an actual installation in "Notes on Electric Furnace Problems." Operating characteristics were pre-determined for the large calcium carbide furnace of the Nitrate Plant, Muscle Shoals. These factors make it practically impossible, at 60 cycles and power factor above 71 per cent, at any voltage under 160, to introduce into the three top electrode arc furnace from one bank of furnace transformers more than approximately 8,600 kva. or 6,000 kw. With electrodes and furnace designed to take and use the power, of course two duplicate banks of transformers and sets of leads, one on either side of the furnace, could deliver a maximum of approximately 17,200 kva. or 12,000 kw. It follows from the above that at 25 cycles this amount of power may easily be supplied to one furnace from one bank of



FIGS. 13, 14, 15, 16—Details of copper electrode holder structure for calcium carbide furnace (Fig. 12, U. S. Nitrate Plant No. 2, Muscle Shoals, Alabama.) This holder and clamp is designed to carry 30,000 amperes.

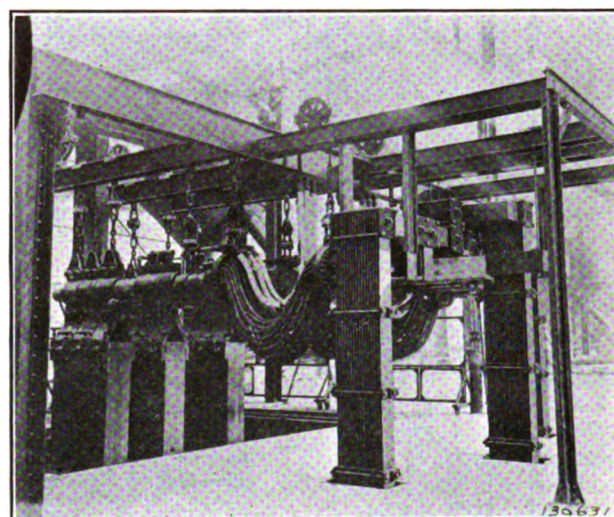


FIG. 10—One of 12 Calcium Carbide Furnaces—36 tons per day capacity each, U. S. Nitrate Plant No. 2, Muscle Shoals, Alabama. Shows low-tension bus, flexibles and assembled electrode with water-cooled clamps in place. This furnace designed to take about 30,000 amperes per leg at approximately 160 volts. The 3-phase, 60-cycle power is therefore approximately 8,600 kva., or 6,000 kw., at 71 per cent power factor.

transformers. In fact, at Niagara Falls several electro metallurgical furnaces have been operating at such a capacity for some years.

In the recently built (60-ton per heat,) 60-cycle, electric steel-melting furnace at the Henry Ford plant, as shown by sketch of Fig. 11, the equivalent of 8 or 12 electrodes, four sets of three-phase secondary busses and connections and four separate 3,000 kva. banks of transformers are to be employed; so that the electrical problem of delivering power to this largest electric steel-melting furnace is not so difficult as has been the case in connection with some ferro-alloy and non-ferrous smelting furnaces, although in this case each electrode connected transformer is to deliver at full load 12,800 amperes at 90 volts, and each hearth connected transformer 17,900 amperes at 39 volts. By means of switching, the eight top electrodes, only, may be used when melting down or when starting furnace up cold. By this connection higher voltage

at the furnace is obtained than by the other connection employing the top and bottom contacts which is used when molten bath is obtained or for refining and superheating.

Industrial installations of large synchronous converters entail the handling of heavy currents at low voltages. For electro-metallurgical or electrolytic

amperes to electrolytic cell circuits in electro-metallurgical plants producing copper, zinc and aluminum, such as the New Cornelia Copper Company, Ajo, Ariz.; the Chile Copper Company, Chuquicamata, Chile; the Anaconda Copper Company, Great Falls, Mont.; and the Aluminum Company of America, at various plants. The particular points to be taken into consideration in connection with such direct current busses are temperature, efficiency losses and mechanical strength, against weight and magnetic effects.

The low-tension busses connecting the transformers with the synchronous converters supplying the electrolytic circuits, however, require special consideration in respect to the choking and unbalancing effects of inductance. Approximately balanced voltage must be supplied to the collector rings of the synchronous converter to prevent unequal currents and excessive heating in parts of the armature winding. Approximately balanced voltage and low inductive voltage drop are desirable in order to permit self-starting from the alternating current circuit. The reason is apparent from the following example: The synchronous booster converters supplying the electrolytic copper cell circuits at Chuquicamata are rated at 12,000 amperes dc., over a normal range of from 202 to 290 volts, and operate on 50-cycle power. The transformers have secondary voltages of 183 and 122 corresponding to 6 and 4 turns. The calculated impedance of the starting circuit is:

Synchronous converter	.0071	ohms per phase
Copper strap leads.....	.001144	ohms per phase
Cable leads	.00096	ohms per phase
Transf. on stg. tap.....	.00111	ohms per phase

.010314

Starting current per phase is, accordingly, 122 volts divided by .010314, or 11,850 amperes. Starting kva. is, therefore, 4,330. The next lower possible transformer voltage corresponding to 3 turns, that is 91½ volts would not give sufficient torque to start the synchronous converter.

It is apparent that with such large starting currents at a power factor not over 50 per cent, the effect of inductance makes a short bus essential and introduces considerable difficulty in selecting a starting voltage which will be sufficient to start the converter and yet will be no higher than necessary and will therefore cause no more starting kva. than necessary to be taken from the line. Where convenient to use forced oil pressure under the shaft, at the bearings, the torque required to rotate the rotor in this type of machine may be reduced to about 1/10, and the measurable kva. taken at starting from the ac. end reduced to about ¼. Oil pressure must be advocated when either low starting kva. is required or difficulty is experienced in starting, due to insufficient voltage, such as may occur if the principles which are here discussed are not given proper consideration in the low tension bus design.

It is apparent that individual installations will vary considerably as to detail but, as indicated, they will all depend upon the same fundamentals. A thorough understanding of the proper methods of employing the principles involved in practical work can probably be best obtained through a complete presentation of the detailed mathematical calculation required in the analysis of an actual installation. For

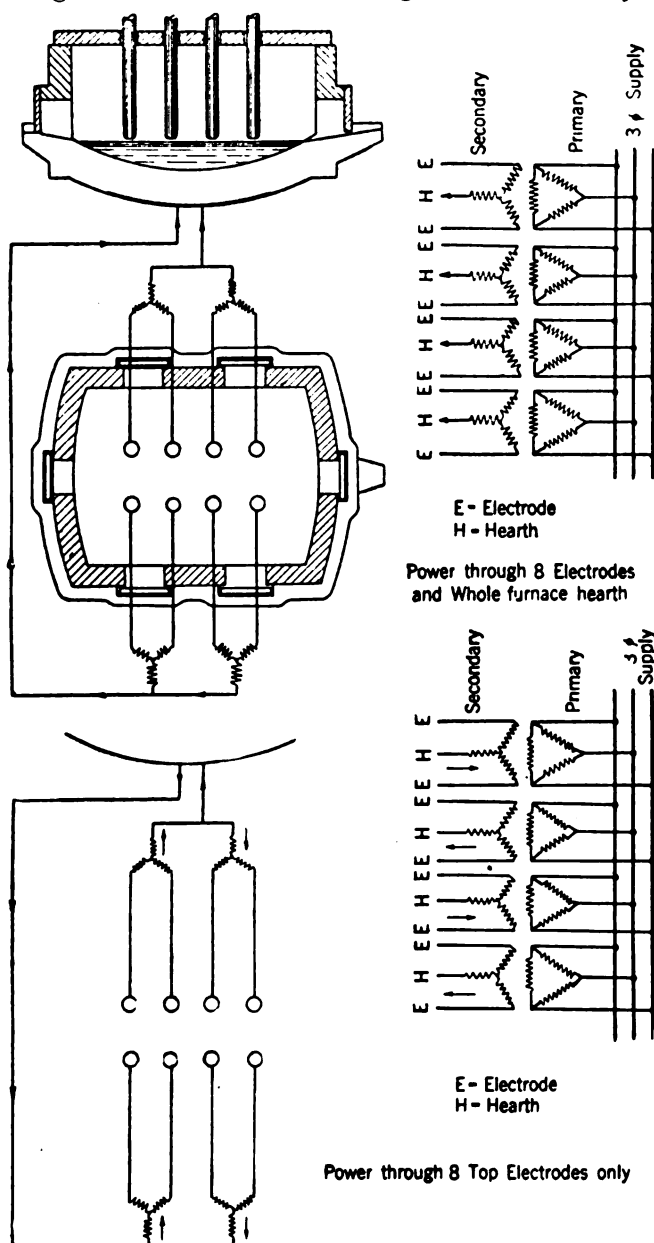


FIG. 11—Sixty-ton Greaves Etnell furnace at the Ford plant in Detroit.

service in chemical plants this apparatus is usually operated continuously at full rated ampere load. For general industrial service where the load always varies considerably from time to time, apparatus is usually installed having a two-hour 25 per cent or 50 per cent overload capacity. It is, accordingly, very general practice to calculate the bus at normal full load at about 600 amperes per square inch for 60 cycles, 800 amperes per square inch for 25 cycles, and 1,000 amperes per square inch for direct current.

Probably the largest heavy current-carrying busses found in industrial plants are the 170, 265 and 500 volt direct current busses carrying from 10,000 to 15,000

this purpose a comparatively difficult example of a six-ton electric steel furnace is chosen in which local shop conditions required that the transformer be placed at a considerable elevation above the furnace and a considerable distance therefrom. This installation of furnace and secondary transformer connections is shown in Fig. 12. As shown by sketch "A" (Fig. 17), it was necessary to place the transformer so that the length of each phase carrying 11,000 amperes is approximately 43 feet from transformer terminals to furnace electrodes. This installation is a Ludlum furnace at the Trafford Foundry of the Westinghouse Electric and Manufacturing Company.

The advantages of "interlacing" where practicable are shown; as calculations are given for both "interlaced" and "non-interlaced conditions and an improvement of from 5 per cent to 2 per cent in power factor is obtained, depending upon the operating voltage. After considerable preliminary calculation, the secondary bus lead arrangement shown in sketch "A" was chosen, with sections shown in sketch "B" (Fig. 18). It was found most economical to work with an average current density at 11,000 amperes of 917 amperes per sq. in. for the strap, 935 amperes per sq. in. for the flexibles and 140 amperes per sq. in. for the graphite electrodes. The detailed calculations are as follows:

Section No. 2—Sketch "B"—6 ft. 2 in. Horizontal Run

Self-inductance of two $\frac{1}{4}$ in. by 12 in. bars spaced $\frac{1}{2}$ in. centers.

$$L = 2l \left[\log_e \frac{2l}{(r_g d^1)^{1/2}} - 1 \right] \text{ (formula 121 modified, } (r_g d^1)^{1/2} \text{)}$$

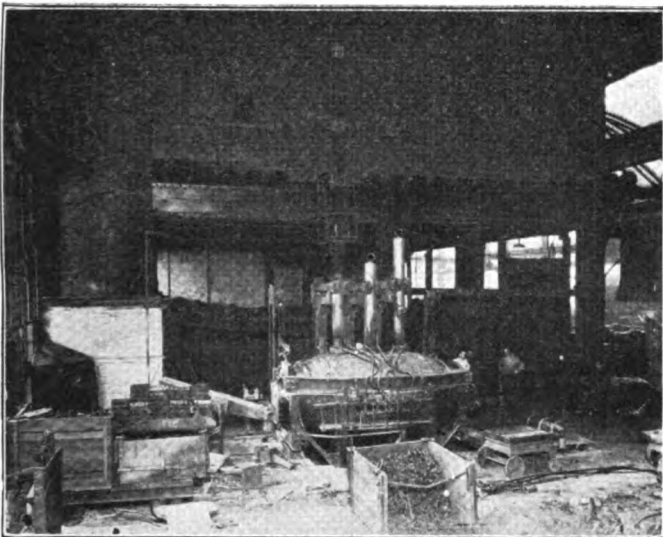


FIG. 12—Six-ton Ludlum electric furnace, Trafford City Steel Foundry, Westinghouse Electric and Manufacturing Company.

In the foreground is a bucket containing steel turnings; and to the left is a carload of light charging scrap, including 3-in. shells. Also to the left is a spout for charging hot metal to assist in starting a heat. The furnace is shown in the center with the low-tension interlaced bus coming down from the transformer on the floor above. This furnace is equipped with three 11-in. graphite electrodes on a 27-in. separation. The bottom lining is at present 9 in. of ganister over 9 in. of brick. The 30-ton reverberatory coal-fired air furnace to the rear and left, for the purpose of making large iron castings, indicates why it was necessary to place transformer as located.

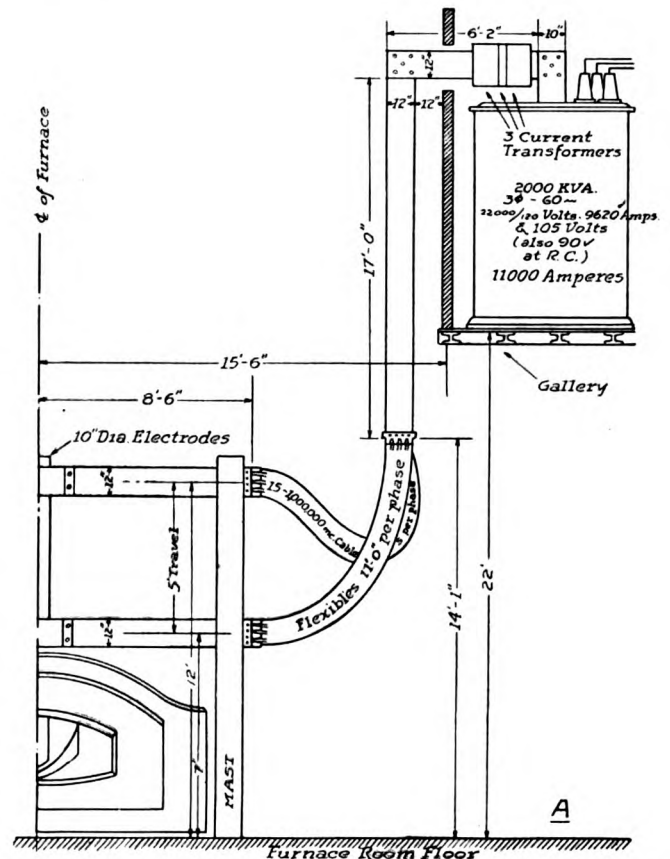


FIG. 17—Sketch "A", showing distance transformer is placed from furnace.

Bureau of Standards, Bulletin No. 169).

$$\text{From curve No. 1, } r_g \left\{ \begin{array}{l} = .2235 \text{ (constant, nearly)} \\ \times (a + b). \\ = 6.96; \text{ and from curve} \\ \text{No. 2, } d^1 = 7.62 \text{ cms. (Di-} \\ \text{mensions in inches on} \\ \text{curves are converted to} \\ \text{cms. in text. } L, \text{ therefore} \\ = 1080 \text{ cms.} \end{array} \right.$$

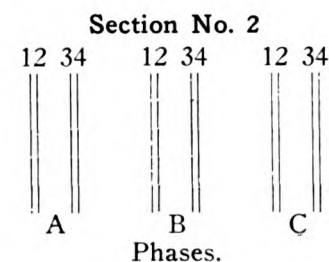
In calculating the mutual inductance between phases and between pairs of conductors in the same phase,—each pair of $\frac{1}{4}$ in. x 12 in. bars spaced $\frac{1}{2}$ in. centers is considered to be equivalent to one $\frac{1}{2}$ in. x 12 in. bar placed at the center line of the two actual bars. Therefore, the 12 actual bars are represented by six $\frac{1}{2}$ in. x 12 in. bars on equal phase spacing of centers.

Mutual inductance between two $\frac{1}{2}$ in. x 12 in. bars:

$$M = 2l \left[\log_e \frac{2l}{d^1} - 1 + \frac{d^1}{l} \right] \text{ (formula 99 modified, Bu-}$$

reau of Standards, Bulletin No. 169).

From curve No. 3, $d^1 = 26.3$. Therefore $M = 677$ cms.



Other values of "M" were calculated in similar manner, corresponding to various separations, and were plotted in curve No. 4.

Combined inductance of phase A. In this connection it should be noted that but $\frac{1}{2}$ the mutual of phases B and C is in phase with "L" of phase A. The "j" components represent actual energy components.

SKETCH "B"

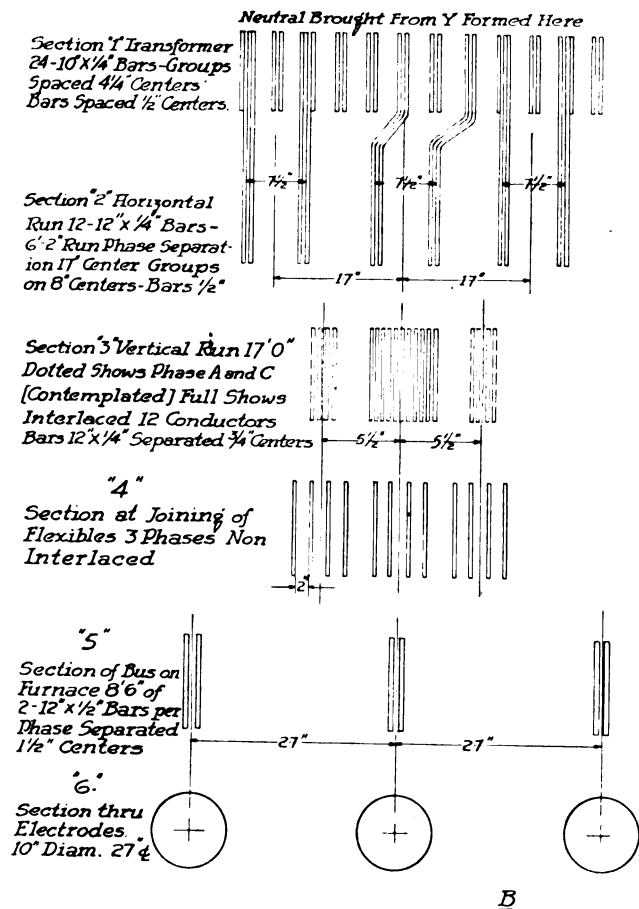


FIG. 18.

Total (quadrature) inductance of phase A = $L_A + M_A - \frac{1}{2}M_B - \frac{1}{2}M_C$

Total energy component phase A = $jL_A + jM_A + .866M_B - .866M_C$

From curve No. 4 the following is obtained for combined inductance leads (12) A.

Phase of Current in "A."

Self-inductance + 1080 + jo

Mutual inductance from—

A34, 8-in. sept. + 707 + jo

B12, 17-in. sep. - 253 + j439

B34, 25-in. sep. - 205 + j355

C12, 34-in. sep. - 171 - j296

C34, 42-in. sep. - 150 - j260

Inductance leads 12A = + 1787 - 779 + j238
= 1008 + j238.

In similar manner inductance leads (34) A = 825 + j382. "Effective" inductance of phase A =

$$\frac{1}{1} = + 453 + j147.$$

$$1008 + j238 + 825 + j382$$

"Average" inductance of phase A =

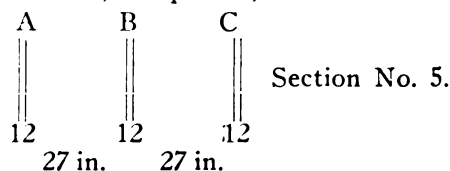
$$\frac{1008 + j238 + 825 + j382}{2 \times 2} = + 459 + j155.$$

The effective inductance of phase A, + 453 + j147, was used for calculating reactance drop. Phases A and C are symmetrical and hence inductances are equal—except for opposite energy components.

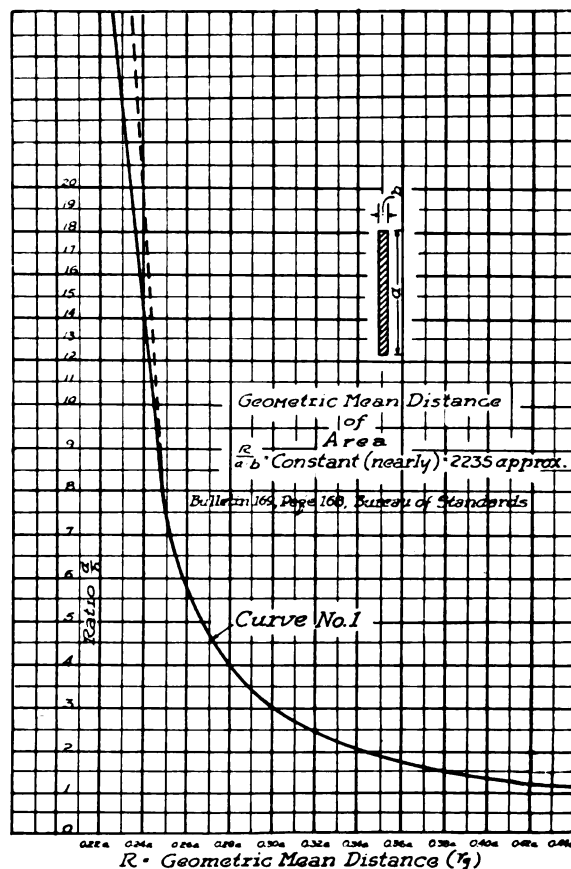
Inductance of phase B was calculated in similar manner. Leads (12) B and (34) B being symmetrical, the resultant inductance of phase B (effective = average) = 369 + jo cms.

Section No. 5—Sketch "B"—8 ft. 6 in. Run on Furnace

Each phase, 2-1/2-in. x 12-in. bars separated 1 1/2-in. centers, 27-in. phase centers. From curve No. 1, $r_g = 7.10$, and from curve No. 2, $d' = 8.94$. By formula 121, given above, L equals 1,640 cms.



Various values for "M" corresponding to different separations were calculated by formula No. 99, given



above and plotted in curve No. 5. For phase A, lead No. 1, using values of "M" from curve, and "L," as calculated in preceding paragraph:

Self-inductance + 1640 + jo

Mutual inductance from—

A2, 1 1/2-in. sep. + 1570 + jo

B1, 27 -in. sep. - 325 + j563

B2, 28 1/2-in. sep. - 320 + j555

C1, 54 -in. sep. - 220 - j381

C2, 55 1/2-in. sep. - 215 - j372

Total + 3210 + jo - 1080 + j365

Lead No. 2 of phase A will be practically the same, i. e., $+2130 + j365$ cms. Inductance of phase A will be half this amount, or $1065 + j183$ cms.

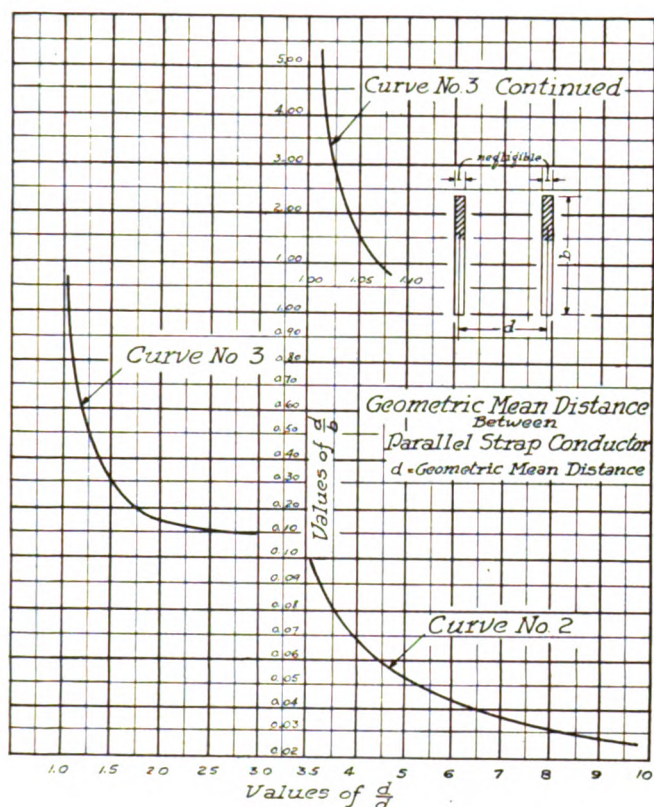
Inductance of phase C, by similar calculation, is $1065 - j183$ cms.

Inductance of phase B, by similar calculation, is $950 + jo$.

Section No. 3—Sketch "B"—17 in. Run—Non-interlaced.

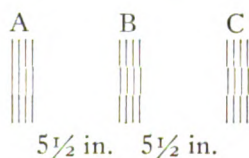
Four $\frac{1}{4}$ -in x 12-in. bars in parallel per phase, center to center of bars $\frac{3}{4}$ -in., phase separation $5\frac{1}{2}$ -in. center to center.

In this calculation it is assumed that each phase group of four bars in parallel is equivalent to a solid



conductor, $2\frac{1}{2}$ -in. x 12-in. section; phase centers $5\frac{1}{2}$ -in. Self-inductance of one conductor $2\frac{1}{2}$ -in. x 12-in.:

$$L = 2l \left[\log_e \frac{2l}{R} - 1 + \frac{R}{l} \right]$$



Section No. 3.

From curve No. 1, $R = 7.25$. Hence " L " = 4,100 cms.

Mutual inductance on phase A from phase B is determined by formula No. 99, as given above. From curve No. 3, d^1 is 18.3. " M " is, accordingly, 3,180 cms.

Mutual inductance on phase A from phase C is similarly determined to be 2,670 cms.

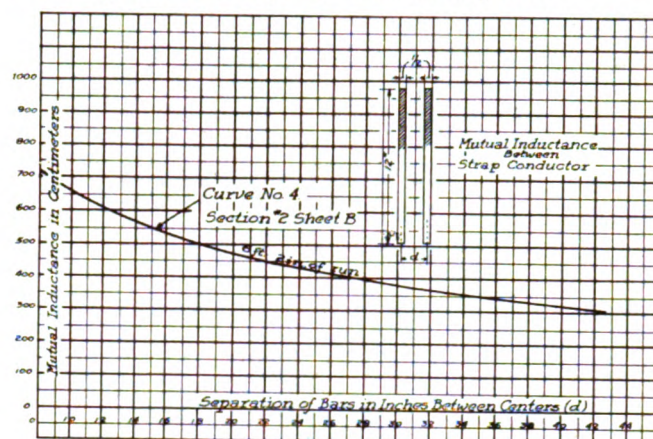
Combined inductance of phase A is, therefore, as follows:

$$\begin{aligned} \text{Self inductance} & \dots\dots\dots + 4100 + jo \\ \text{Mutual inductance from B} & \dots\dots\dots - 1590 + j2750 \\ \text{Mutual inductance from C} & \dots\dots\dots - 1330 - j2310 \end{aligned}$$

$$\text{Totals} \dots\dots\dots + 4100 + jo - 2920 + j440$$

The resultant inductance of phase A is $1180 + j440$ cms.

Combined or resultant inductance of phase C is same as phase A except " j " term is negative.



Sketch "C" shows the phase relations of these various quantities.

Combined inductance of phase B is similarly determined to be $920 + jo$.

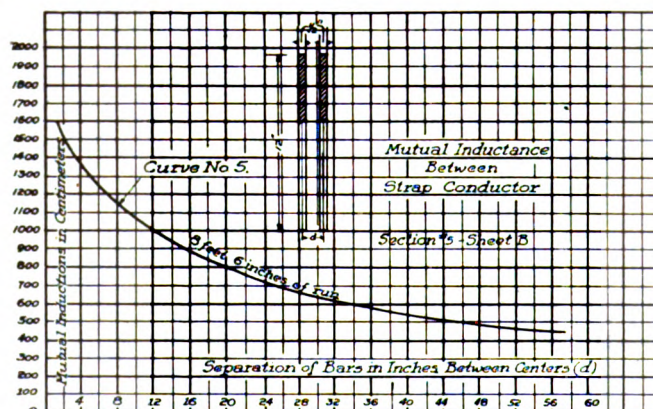
Section No. 3—Sketch "B"—17 ft. Run—Interlaced.

"R," by curve No. 1, = 6.96. By same formula for self-inductance, " L " = 4150 cms.

Mutual inductance " M ," for various bar separations, calculated by same formula for mutual induction, is shown by curve No. 6.

$\frac{M}{2}$, inductance component, and $j.866 M$, energy component, are readily obtained from this curve.

Mutual inductance of phase A (four parallel connected bars) to other two phases and to itself:

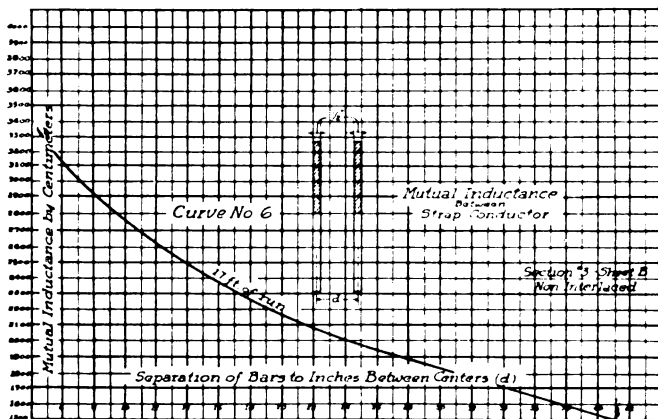


TO OTHER PHASES.

M from	to bar A ₁	to bar A ₂	to bar A ₃	to bar A ₄
B ₁	-2030 + j3520	-1940 + j3360	-1710 + j2980	-1552 + j2690
C ₁	-1940 - j3360	-2030 - j3520	-1777 - j3080	-1599 - j2770
B ₂	-1777 + j3080	-2030 + j3520	-1940 + j3360	-1710 + j2980
C ₂	-1710 - j2980	-1940 - j3360	-2030 - j3520	-1777 - j3080
B ₃	-1599 + j2770	-1777 + j3080	-2030 + j3520	-1940 + j3360
C ₃	-1552 - j2690	-1710 - j2980	-1940 - j3360	-2030 - j3520
B ₄	-1478 + j2560	-1599 + j2770	-1777 + j3080	-2030 + j3520
C ₄	-1452 - j2520	-1552 - j2690	-1710 - j2980	-1940 - j3360
	-13538 + j380	-14578 + j180	-14914 + jo	-14578 - j180

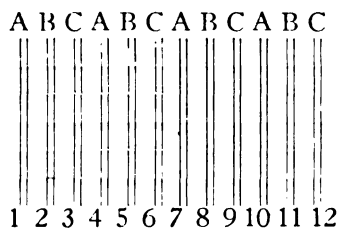
TO ITSELF

M from		M from	
A ₄	+3710+j0	A ₁	+3300+j0
A ₇	+3300+j0	A ₄	+3710+j0
A ₁₀	+3026+j0	A ₁₀	+3710+j0
Self-Induct.	+4150+j0	Self-Induct.	+4150+j0
	+14186+j0		+14870+j0
	-13538+j380		-14914+j0
Net	+648+j380	Net	-44+j0
M from		M from	
A ₁	+3710+j0	A ₁	+3026+j0
A ₇	+3710+j0	A ₄	+3300+j0
A ₁₀	+3300+j0	A ₇	+3710+j0
	+4150+j0		+4150+j0
	+14870+j0		+14186+j0
	-14578+j180		-14578+j180
	+292+j180		-392-j180



Inductance "Average" $\frac{Z(L+M)}{4}$ for phase A = +126 + j94 cms.

Phase C is symmetrical with phase A. "Average" inductance of phase C = +216 - j94 cms.



Section No. 3.

Phase B (leads B₂ and B₃ are symmetrical with leads B₈ and B₁₁, respectively).

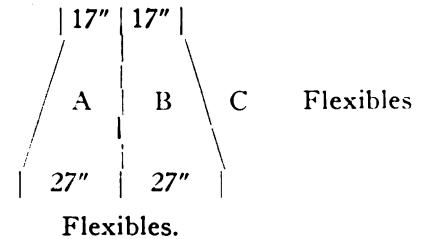
M from	to bar B ₂	to bar B ₃
A ₁	+2030+j3520	-1777+j3080
A ₃	+2030-j3520	-1940-j3360
A ₄	-1940+j3360	-2030+j3520
A ₆	-1777-j3080	-2030-j3520
A ₇	-1710+j2980	-1940+j3360
A ₈	-1599-j2770	-1777-j3080
A ₁₀	-1552+j2690	-1710+j2980
A ₁₂	-1478-j2560	-1599-j2770
	-14116+j720	-14803+j210

Phase B leads are exactly symmetrical with regard to phases A and C.

Energy component will be -j720 and -j210 for leads B₁₁ and B₈, respectively, and this term will cancel for resultant phase value.

M from		M from	
B ₂	+3710+j0	B ₂	+3710+j0
B ₃	+3300+j0	B ₄	+3710+j0
B ₁₁	+3026+j0	B ₁₁	+3300+j0
Self-Induct.	+4150+j0		+4150+j0
	+14186+j0		+14870+j0
	-14116+j720		-14803+j210
	+70+j720		+67+j210

"Average" inductance of phase B is then equal to +68.5 + j0.



11 ft. Run of Flexibles—Sketch A.

Each phase consists of fifteen one million circular mill cables in parallel. Equivalent separation of flexibles = 21.4 in. Self-inductance of bunched fifteen cables (assuming all tier in a bundle of approximately 6-in. diameter) is:

$$L = 2l \left[\log_e \frac{2l}{R} - 1 + \frac{u}{4} \right]$$

"u" = 1. "R" = 7.62. Hence "L" = 2490 cms.

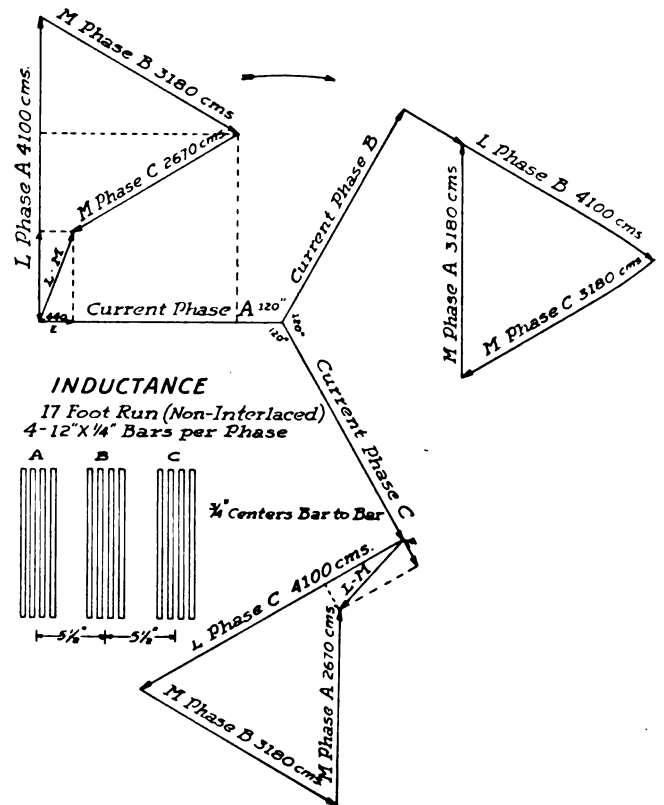


FIG. 19—Sketch C.

Mutual inductance to phase B from phase A, by formula already given, d¹ being 21.4 x 2.54 or 54.4 cms., is 1110 cms.

Mutual inductance to phase C from phase A, d¹ being 108.8 cms., is 764 cms.

Resultant inductance of phase A = +2490+j0 self-induct.
 Mutual to B..... - 555+j961
 Mutual to C..... - 382-j662

Resultant inductance phase A = +1553+j299

Phase C is symmetrical with phase A and hence inductance is + 1553 - j299.

Phase B, self-inductance, = +2490+j0
 Mutual to A..... - 555+j961
 Mutual to C..... - 555-j961

Resultant inductance phase B = +1380+j0

Section No. 6—Sketch "B"—Electrodes 5 ft. Long 10 in. Diameter.

The electrodes are spaced 27 in. center to center. Self-inductance by formula No. 96, Bureau of Standards Bulletin No. 169, is:

$$L = 2l \left[\log_e \frac{2l}{\text{radius}} - \frac{3}{4} \right] = 740 \text{ cms.}$$

Mutual inductance may be obtained by formula No. 99 since no lines of force cut the end for leakage—i. e., bus is continuous even though electrodes themselves are relatively short. "M," therefore, = 286 cms., for the 27-in. separation phase A to phase B.

By the same formula, mutual inductance, phase A to phase C, for 54-in. separation, = 210 cms.

Phase A, self-inductance, = +740+j0
 Mutual to phase B..... -143+j248
 Mutual to phase C..... -105-j182

Resultant induct. phase A = +492+j66

Phase C electrode is symmetrical with phase A and resultant inductance = + 492 - j66.

By similar calculation, resultant inductance, phase B electrode, = + 454 + j0.

Combined Inductance of Secondary Bus of Phase A.

Section	Inductance in cms.	Inductance in. cms.
Section No. 2.....	+ 453+j147	+ 453+j147
Section No. 3 (Non-interlaced)	+1180+j440	
Section No. 3 (Interlaced)		+ 126+j94
11 ft. Flexibles	+1553+j299	+1553+j299
Section No. 5.....	+1065+j183	+1065+j183
Section No. 6.....	+ 492+j66	+ 492+j66
Combined layout	+4743+j1135	+3689+j789
Phase C is.....	+4743-j1135	+3689-j789

Reactance.

2,000 kva., 120 v. star, 9620 amperes, $X_L = 8.1\%$
 = 5.62 v. for transformer.

2,000 kva., 105 v. star, 11,000 amperes $X = 10.6\%$
 = 6.43 v. for transformer.

1,710 kva., 90 v. star, 11,000 amperes, $X = 12.3\%$
 = 6.4 v. for transformer.

$X_L = 2 \pi f L \times 10^{-9} = 2 \pi \times 60 L \times 10^{-9} = 377 L \times 10^{-9} \text{ ohms.}$

Phase A.

Combined layout reactance = + .001790 + j.000427 (17 ft. run non-interlaced).

Combined layout reactance = + .001394 + j.000297 (17 ft. run interlaced).

Phase C is same as Phase A, except for negative j component.

If phases A, B and C were placed at the apices of an equilateral triangle their inductances would be the same and they would have no unbalancing tendency.

Combined Inductance of Secondary Bus of Phase B.

Section	Inductance in cms.	Inductance in. cms.
No. 2, Sketch B.....	+ 369+j0	+ 369+j0
No. 3, Sketch B (Non-interlaced)	+ 920+j0	
No. 3, Sketch B (Interlaced)		+ 68.5+j0
11 ft. Flexibles, Sketch A	+1380+j0	+1380+j0
No. 5, Sketch B.....	+ 950+j0	+ 950+j0
No. 6, Sketch B.....	+ 454+j0	+ 454+j0
Combined Inductance..	+4073+j0	+3222+j0

$$X_L = 377 L \times 10^{-9} \text{ ohms } (+.001536+j0) \quad (+.001214+j0)$$

Based on Figures for Phase A.

17 Ft. Run Non-Interlaced—120 V.

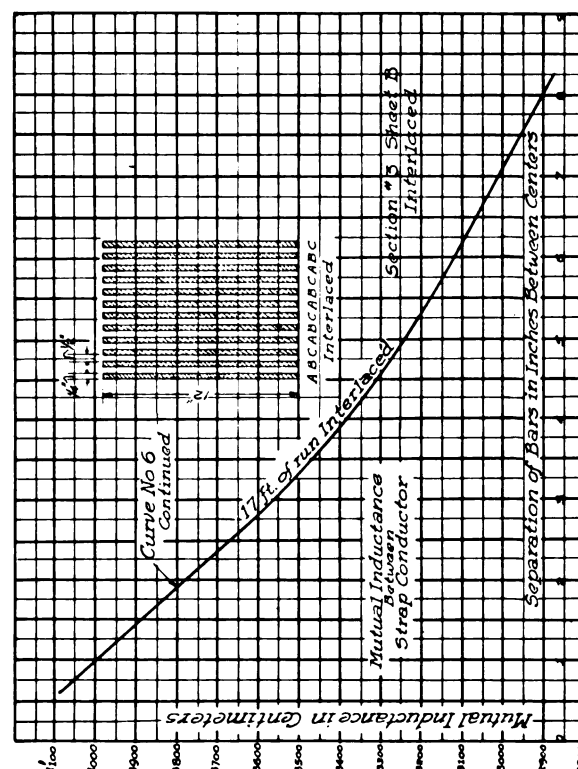
Total volt drop = transf. + leads.

Total volt drop = + 5.62 (+ 17.2 + j4.1).

Total volt drop = + 22.8 + j4.1 volts.

$$\%X_L = \frac{22.8}{69.3} \times 100 = 32.9\% \quad \text{P. F.} = 94\%.$$

"j" unbalance = 5.9%.



17 Ft. Run Interlaced—120 V.

= 5.62 + (+ 13.4 + j2.9).

= 19.0 + j2.9 volts

$$X_L = \frac{19.0}{69.3} \times 100 = 27.4\% \quad \text{P. F.} = 96\%.$$

"j" unbalance = 4.2%.

17 Ft. Run Non-Interlaced—105 V.

Total volt drop = 6.43 + (+ 19.7 + j4.7) = 26.1 + j4.7.

$$\%X_L = \frac{26.1}{60.6} \times 100 = 43.1\% \quad \text{P. F.} = 90\%.$$

"j" unbalance = 7.7%.

17 Ft. Run Interlaced—105 V.

$$= 5.43 + j15.3 + j3.3 = 21.7 + j3.3.$$

$$X_L = \frac{21.7}{60.6} \times 100 = 35.8\% \quad \text{P. F.} = 93\%.$$

$$\text{"j" unbalance} = 5.4\%.$$

17 Ft. Run Non-Interlaced—90 V.

$$\text{Total volt drop} = 6.40 (+ 19.7 + j4.7) = 26.1 + j4.7.$$

$$\%X_L = \frac{26.1}{52.0} \times 100 = 50.2\% \quad \text{P. F.} = 86\%.$$

$$\text{"j" unbalance} = 9.0\%.$$

17 Ft. Run Interlaced—90 V.

$$= 6.40 + (15.3 + j3.3) = 21.7 + j3.3.$$

$$X_L = \frac{21.7}{52.0} \times 100 = 41.8\% \quad \text{P. F.} = 91\%.$$

$$\text{"j" unbalance} = 6.3\%.$$

This analysis shows, therefore, that with the electrical structure employed a power factor at full rated transformer load will be obtained at the high tension side of from 91 per cent to 96 per cent, depending upon which secondary transformer voltage is being supplied to the furnace. It also shows that if sufficient care is employed in the design very heavy currents, at 60 cycles, may be carried short distances by means of structures which are not spaced altogether symmetrically, from a mechanical standpoint, without appreciable or undesirable unbalancing resulting. The automatic furnace regulator of course tends to counteract at the furnace whatever unbalancing the bus lead connections tend to introduce, and, when properly adjusted, functions to cause equal power to be consumed at each electrode arc. In order to prevent the effects of unbalancing from reaching back into the power supply system, however, it is unquestionably better engineering judgment to design the bus layout with the minimum of unbalancing effect consistent with mechanical practicability. In fact, with each phase power load automatically held equal, the unequal currents which flow due to unbalancing tend to accentuate the unbalancing, and hence a design which introduces the minimum of unbalancing tendency is all the more advisable.

The example given illustrates principles which apply to all industrial power bus design, whether for very low voltage, standard 220 volts or 440 volts, or circuits of higher voltage. Temperature rise limits are set by A. I. E. E. Standardization Rules. Ratings are based on an ambient temperature of 40 deg. C. Except for high altitudes and certain hot climates, such as sections of our Southwest, this basis is adequate. Bare busses and bare conductors may be operated at temperatures not exceeding 90 deg. C., provided their location or connection does not increase the temperature of connected switching devices above 70 deg. C., or of connected insulated conductors above A. I. E. E. Rules. The temperature rise for insulated conductors where employed should be in accordance with A. I. E. E. Rules. The whole electrical installation should be such that it can be erected and installed to comply with the National Electrical Code and such parts of the National Electrical Safety Code as apply. This can usually be accomplished by proportioning the parts and restricting the current density to not over 1,000 amperes per square inch of cross section

for commercially pure copper, and 200 amperes per square inch of area of surface held together by rivets, screws or bolts.

General Tripp Receives Highest Civilian Order from Japanese Government

The government of Japan has conferred the second degree order of the Sacred Treasurer upon General Guy E. Tripp, chairman of the board of the Westinghouse Electric & Manufacturing Company. This is the highest decoration that can be awarded a civilian foreigner by the Japanese government.

General Tripp is in Japan at the present time in connection with reconstruction work following the recent severe earthquake, and his decoration was in recognition of his activities in assisting the Japanese officials in rebuilding the devastated area. His executive and organizing ability has made him famous in the industrial and financial world. This ability won



GEN. GUY E. TRIPP

him the commission of major in the Ordnance Department of the army during the recent world war, and a promotion within 10 months to brigadier-general and assistant to the chief of ordnance. For meritorious service in this position, the Distinguished Service Medal was conferred upon him by the President of the United States.

General Tripp was born April 22, 1865, in Wells, Me., where he spent the first years of his life. His only academic instruction was received at Berwick Academy, Houlton, Me. Here he studied for two years. On the completion of his education, he found employment as a clerk in a grocery store. In 1882 the Eastern Railroad employed him as a clerk, in which position he remained until 1889, when he trans-

(Continued on page 648)

Small Heavy Locomotives

Steel Mill Limitations Overcome by Various Departures from Design Principles

SOME rather unique locomotives recently built by H. K. Porter Company of Pittsburgh, Pa., for the Jones & Laughlin Steel Corporation are illustrated in the accompanying photograph, and briefly described in the following text. The uniqueness lies principally in the great weight carried on a short wheelbase and narrow gauge track.

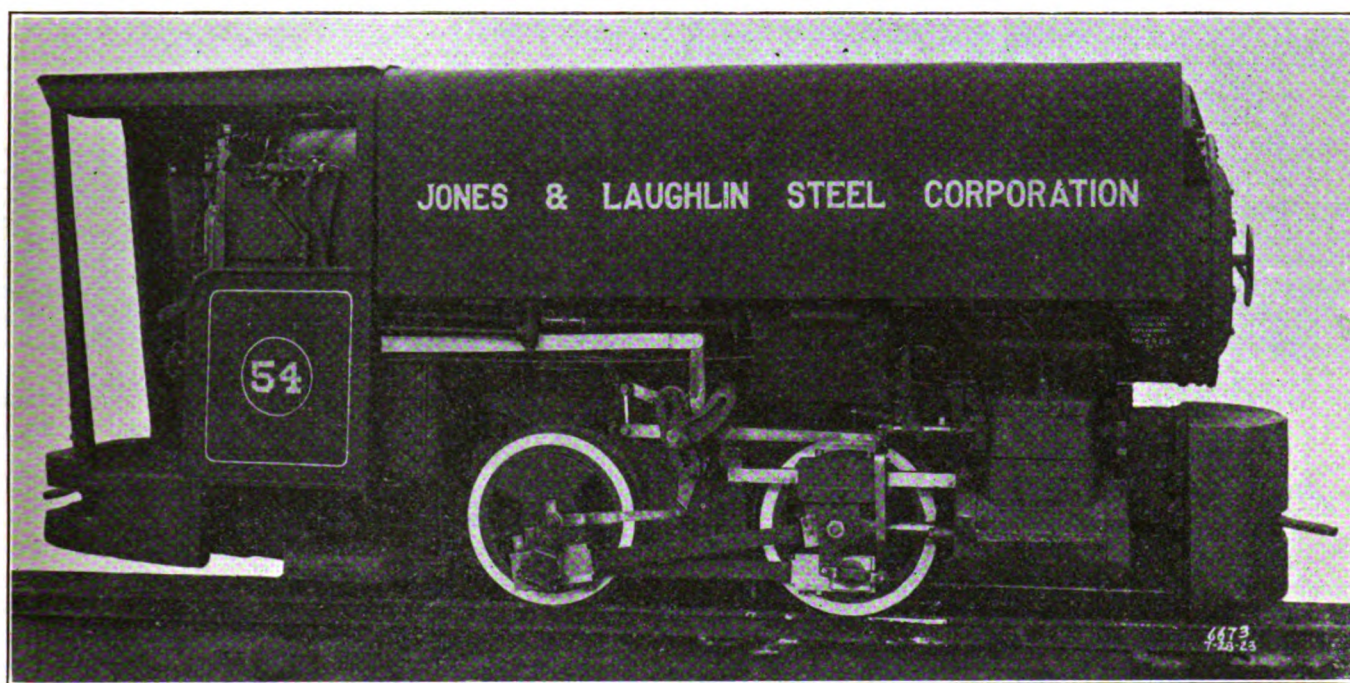
There were many limiting functions entering into the design that, in a measure, prohibited the following out of generally accepted principles of locomotive design and caused a departure from such principles, or rather some modifications of ratios, etc.

Due to mill conditions for clearance, the overall height was limited to 7 ft. 3 in. and the width to 4 ft.

construction slab 3 in. thick with practically no cut-outs except for the journal boxes, and as required for the cylinders, firebox, etc.

Walschaert valve gear has been used. This places the moving parts where they can be easily oiled and cared for, and yet these parts are fully protected from accident by heavy castings at front and rear. Stephenson link motion had been used on this class of locomotives previously, but with such a narrow gauge and large driving boxes as well as crowded conditions, the Walschaert gear is decidedly to be preferred.

It will be observed that the front and rear cast steel bumpers are of great weight and hung closely



Unique locomotive recently designed for special service conditions.

10 in. over a gauge of 23 in. The curvature of the track required a wheelbase of not over 48 in. and with heavy duty and an extremely slippery rail, weight of about 60,000 was desired for adhesion. The extreme length over bumpers is 17 ft., yet the load on track is distributed over the very small area of 1,104 sq. in., or about 54 lbs. per sq. in. of track area. These locomotives are operated over a roadbed constructed of 120-lb. rails and steel cross ties.

This weight on a locomotive of this size, where the weight would normally be about 40,000, required the addition of weight wherever possible, without interference with working parts. The needed excess weight was added in many places, having in view the necessity of correct distribution and the desire for symmetrical lines. For example, the saddle tank weighs about 6,500 lbs., the boiler front is of double thickness, as is also the smoke stack; the steam chests and cylinders are massively built; the frames are of

to the rail. These perform their normal functions as well as provide weight, and act as buffers for foreign obstructions along the tracks.

The steel castings bolted to either side of the frames under the firebox have dual functions. They act as buffers to prevent possible injury to the valve gear and rods, while the engines are in reverse motion; provide weight and at the same time bring the center of gravity to a point where the weight is equally distributed over both driving wheels.

Of the boiler but little may be said of the specific construction, except that for purpose of weight, plate and rivets were increased in size. For boilers of this size and pressure ordinarily $\frac{3}{8}$ -in. plate and $\frac{3}{4}$ -in. rivets are used. In this case $\frac{9}{16}$ -in. plate was used in the shell and wagon top with 1-in. rivets in the horizontal seams. Incidentally the construction of the shell would permit of a working pressure of 280 lbs. at a factor of safety of 5. However, the working

pressure is set at 180, as the firebox is of normal construction and the additional metal in the shell was added for weight only.

The company's usual practice was followed out in using the Porter injector check flange. This flange permits the setting of the water supply opening in the boiler either above or below the center line of the boiler, with the opening in the flange at right angles to the center line and with a full allowance of thread. One size flange may be used on boilers of various diameters.

In order to secure a maximum number of full threads in the washout holes at the mudring corners, the holes are drilled $\frac{1}{2}$ in. small and rolled out with a special roller which thickens the plate at least 25 per cent at the edge of the hole.

The boilers were built to the A. S. M. E. locomotive code, and have all mudring corners autogenously welded. The cylinders are 11x14 in., and driving wheels are 25 in.

No wood whatsoever was used anywhere on the locomotives, the cab and fixtures all being of metal. Due to the necessity for conservation of space the cab is small, all fixtures and moving parts closely placed and the area for the engineer somewhat confined.

Due to heat radiation from the boiler and the operation of the locomotives in close proximity to hot ingots and hot ingot molds, the temperature of the water carried in the saddle tank varies from 100 deg. F. to 140 deg. F., a preheater, so to speak.

Coal is used for fuel; it is carried in an ingot car attached to the back end of the locomotive.

No Substitute for Business Ability

Declares William R. Basset, President of Miller, Franklin, Basset & Company, Inc.

Some men have looked upon the various developments of scientific management as substitutes for old fashioned business ability, shrewdness and the trading instinct. They constitute a large part of those who claim that scientific management is a failure.

Thirty years or so ago, no one expected to succeed in business unless he was a good trader. Then along came the developments of cost accounting, production planning, time study and wage incentives. Executives began to use reports and charts. Some grasped at these new methods with an almost childish belief that they would solve all business troubles, and that systems would take the place of judgment, and make every man equally successful in business. Of course it couldn't be done. The man of natural business capacity who adopted the new methods, increased his lead. But he used systems as helps. A cost system will show the way to greater profits, a production planning system will reduce costs; but they will only do these things when they are used by an otherwise capable man.

The methods of scientific management are not substitutes—they are auxiliaries. They won't take the place of brains, nor will they run the business while the owner basks in Palm Beach.

A system, of itself, can't make money. It can only help the man of ability to make more money.

Power Exhibit in New York City

Second Power Show to Excel in Number, Diversity and Interest of Exhibits.

The number, diversity and interest of the exhibits of the Second Exposition of Power and Mechanical Engineering promise to far excel those of the first exposition held in December, 1922. The 1923 exposition is to be held in the Grand Central Palace, New York City, from Monday, December 3, through Saturday, December 8th. The week of the exposition will be an active period for engineers for during that time meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers will be held. These meetings insure an attendance of influential engineers and executives. In addition, the National Association of Stationary Engineers, and its affiliated bodies, is organizing the interest of their membership, for last year these men, who are so vitally concerned with the operating problems, found the exposition to be of great educational value.

The exhibits will be supplemented by an extensive program of moving picture films to be presented in co-operation with manufacturers. Last year the picture program was found to interest the layman who was not informed about technical processes and the engineer whose close application to one field of his work had not enabled him to keep up with progress in the rest of the profession.

About 200 exhibitors have signed contracts for space at the exposition. The devices and apparatus to be exhibited cover the field of power and mechanical engineering from the handling of the coal at the power plant until power is turned into work. Not only will there be representatives of steam generating devices and prime movers but also exhibits of those who have devoted their efforts to the solution of the troublesome problems involved in burning fuel and making and using power, whatever the industry using the heat and power derived. The generation of heat and the production of power are factors common to all industries though they may vary in importance over a wide range. The factory whose principal production is small metal parts will have a power cost that is a small per cent of the total, while at the other extreme is the manufacture of electricity. There are many industries, such as the metallurgical, ceramic, textile, rubber and cement, whose engineers will be vitally interested in this exposition as all of these industries are large users of fuel.

One especially interesting section of exhibits at the coming exposition will be that devoted to meters and other instruments for power-plant control. The great development in metering devices is comparatively recent and to this development many devices in fuel economy can be traced. In fact, better instrument equipment has replaced art by science in many boiler room operations. The coming exposition promises many novelties in this field.

The managers of the exposition are Fred W. Payne and Charles F. Roth, with offices in the Grand Central Palace.

THE SAFETY CRUSADE

ADULT wage earners, who wish to receive technical training which will help them in their occupations, may now secure such training from the public school, announces the Federal Board for Vocational Education.

Under the Federal and state vocational education acts, funds are available to assist the public schools in each community to set up adult evening classes for wage earners. To receive such instruction, it is necessary that a group of workers, employed in a common industry, take the initiative by organizing themselves into a class. Next, they should present themselves to the local school authorities and request an instruc-

night school course last year, all passed, giving a 100 per cent record to the schools.

Workers in many other communities would duplicate the record of the Illinois miners were they aware that the opportunity of public school instruction is open to them, it is believed. Hitherto it has been the impression of the general public that public school vocational education was restricted to boys and girls. However, adult education has a high place on the program of the Federal and state boards of vocational education. It is only necessary that the workers themselves take the initiative in asking for it, the Federal board declares.



A segregated section for specialized training.



Typically the same equipment as in the plant proper.

tor. The local school board is empowered to provide an instructor and a class room to the applicants. Thereupon the class begins its sessions on a regular nightly schedule.

In some cases no instructor qualified to teach the desired subject is available. In such cases the local school authorities may call upon the state supervisor of trade and industrial education. The state supervisor details an instructor to the community. If no technically qualified instructor is available in the state, the supervisor takes steps to train an instructor especially for the needs of the class. In some cases one of the members of the class is given this training to instruct the others. In no case is a group of workers denied assistance until all possible methods of aid have been exhausted.

The only restriction that the public schools lay upon such adult extension work is that all members of the class be workers, actually employed in the trades for which they desire training. Thus the mistake of training workers for trades in which they can not get employment is avoided.

Successful results have been obtained through such classes in many communities, the board declares. A notable example has been the work among the coal miners in Southern Illinois. Last year, over 1,000 miners were enrolled in evening extension classes, studying to qualify for executive positions. The state supervisor reports that, of the many miners who took examinations for higher positions after completing the

PITTSBURGH'S CONTRIBUTION

With Charts Showing Growth of the Ralston School.

At the suggestion of Dr. William M. Davidson, Superintendent of Schools, the following was written as an introduction to the study of the Bulletin on Vocational Guidance in Pittsburgh Public Schools. The Bulletin, as you know, is one of the required books in our reading circle for this year.

The first time we heard the term vocational guidance, we asked ourselves "What does it mean?" As Alice Barrows said, early in the movement, "Vocational guidance is guidance for training and not guidance for a job." This quotation serves as a fitting introduction to our study. There is much confusion about vocational guidance. Many people are scared about the word "vocational" and think that it means that the school or the teacher is going to decide for children in advance exactly the occupation that they must follow or is planning to send them out of school into life's work as soon as possible. On the contrary, vocational guidance is a continuous process. It aims to aid the child to select scientifically and not by chance, to plan his studies wisely, to enter upon his vocation considerably, and to make progress consistently and continuously.

Ever since man became man he has been guided; therefore, it is not a fad, it is fundamental. Changes

in school population in the higher grades make guidance mandatory. As Burdge says, "You might as well throw the Greek alphabet on the floor and expect to pick up an Odyssey, as to expect the inexperienced, aimless, uncounselled boys to obtain by accident the kind of employment best suited to their growth and development as citizens and wage earners."

Too much cannot be said about the shameful waste of our natural resources but the waste of our human resources has been greater. Vocational guidance is a movement to assist in conserving our human resources. One of the great sources of waste is the drop-out of our schools, especially those under 16 who wish to go to work. Broadly speaking there are no jobs for children under 16 which they ought to take. Remarks from employers corroborate this statement: "Demand older persons with more maturity, reliability, and training." "Aren't ready to learn anything until after 16." "No time to train them in industry." "They waste too much material." "Aren't game to real work—give up too easily." Teachers and parents might say: "Work furnishes little or no training that later may prove valuable." "Likely to get into rut of factory work or habit of shifting from one job to another." "Gain little in money or training." "Much loss in strength and mental development." "Eighty-five per cent in blind alley jobs." The only real worth while job for the 14-16 year-old is in the



Growth of the Ralston School, Pittsburgh

school that will give the best kind of training. As Dr. Allen of Providence, R. I., says, "You cannot make the most of a child vocationally unless you have made the most of him educationally."

Pittsburgh has the most complete system of guidance in this country; counselors for the junior and senior high schools, placement secretaries for children between 14 and 16, placement secretaries for the youth between 16 and 21, and a field secretary for those who drop out. When Dr. Davidson appointed Mr. Burroughs as the first director of the department in 1914, the movement was only six years old in this country. The first bureau was started in Boston in 1908. About this time Mr. E. W. Weaver started placement work in Boys' High School, Brooklyn. Our department was first concerned with working children. Afterwards it developed into the Continuation School, even before the passage of the Continuation School law. In 1918 the department was reorganized and a counselor was appointed for each high school besides placement secretaries in the North School Building and in the Nixon Building.

Giving information about occupations and naming the steps necessary in preparation for life's work, is only one phase of the work of the department of Vocational Guidance in Pittsburgh schools. Giving service to those who are no longer in direct contact with the classroom and to those employers who wish to avail

themselves of the product of the school as their employees, is a necessary complement in making a complete system. You will find how adequately this is done in Pittsburgh by reading the Bulletin. Could not many of the suggestions given to young people seeking employment be emphasized in our classes in all the grades?

The following figures regarding the work of the department show something of the magnitude of the work.

The report of the high school counselors showed 1124 group conferences reaching 40,252 pupils, 171 guidance talks by outside speakers reaching 12,090, and individual conferences with 9,944 boys and 11,091 girls. As the result of conferences 390 pupils were retained in school or returned to school, 1504 parents and 322 employers were interviewed, and a total of 365 visits were made to other schools by the counselors.

During the first two weeks of the present school year, 1103 children passed through the placement office in the North School Building, 661 of these being new applicants for the service. In the Nixon Building office, 768 boys and 911 girls were placed in positions during the first eight months of 1923. When it is considered that, for each placement, there are about six interviews, some conception of the vastness of the work will be gained.

The most successful guidance does not depend upon one or two teachers in a school but upon the hearty co-operation of all the teachers of the school; it must be inherent in the work of every classroom. Every teacher should catch a vision of his or her opportunity and should accept a share of the responsibility of the future of the child. It is possible for a teacher to lose sight of the child in his narrow ambition to shine as a teacher of a special subject. The child is the only object of the school; all studies and activities should be the means and not the end of education. The Bulletin tells how the child may be guided through the maze of electives and through the after-school days.

With the feeling that no vocational guidance department, no matter how highly organized, can be effective without the sympathy and co-operation of the whole teaching force, the committee in charge of the reading circle work decided to place upon the list for this year the Vocational Guidance Bulletin.

Edward Ryneason.

The Tin Industry in the Straits Settlements

Total exports of refined tin from the Straits Settlements during June amounted to 5,285 long tons, compared with 5,335 in May, the share of the United States increasing from 59.14 to 74.36 per cent, while that of the United Kingdom decreased from 26.24 per cent in May to 4.73 in June. Europe, as a whole, received 20.91 per cent the last month and 14.62 the preceding.

The price range for May and June was as follows: Highest, \$109 in May and \$100 in June; lowest, \$97.625 in May and \$96.41 in June, per picul.

The price of tin declined steadily during June. The fact that it was being sold every day on a falling market was taken to indicate that the government was disposing of its stocks. Neither Chinese nor European dealers sell so persistently when quotations are declining. With the price around \$90, a critical point was reached for the Chinese mines, which can not produce at a profit below that figure.

Annealing Sheet Metal for Stamping

By FRANCIS G. WHITE*

PART II

Chemical Composition of Sheets

The chemical composition of the steel has purposely been avoided up until this time. This paper considers a low carbon open-hearth steel about 0.10 per cent carbon, about 0.035 per cent sulphur, about

0.40 per cent manganese and phosphorus varying according to the purpose, use and gage of the sheet. Light gage, such as tin plate, will run around 0.080 per cent phosphorus while heavier gage may run as low as 0.005 per cent.

TABLE 1—ERICHSEN TESTS—SUMMARY OF RESULTS

Test No.	T—Thickness of Sheet				D—Depth of Impression							
	Steel A 18 Gage		Steel B 18 Gage		Steel C 20 Gage		Steel D 22 Gage		Steel E 27 Gage		Steel F 30 Gage	
	T	D	T	D	T	D	T	D	T	D	T	D
1. Heated to 1100° F., cooled slowly	1.42	9.52	1.33	9.25	.90	8.48	.76	6.40	.43	6.00		
	1.39	9.30	1.33	9.58	.93	8.75	.77	6.61	.43	5.98		
	1.37	9.65	1.31	8.84	.93	8.62	.77	6.70	.44	4.90		
	1.37	9.58	1.33	9.32	.91	8.82	.79	6.68	.43	5.08		
	1.37	9.00	1.31	9.27	.92	8.70	.76	6.72	.43	5.15		
Average		9.41		9.25		8.67		6.62		5.42		
2. Heated to 1100° F. held for 18 hrs., cooled slowly	1.38	10.50	1.34	9.77	.95	9.00	.78	7.01	.43	7.20	.31	6.07
	1.39	10.35	1.33	9.90	.94	9.13	.79	7.97	.42	7.15	.30	5.38
	1.38	10.25	1.33	10.15	.95	9.14	.81	7.47	.43	6.85	.32	6.23
	1.38	10.24	1.30	9.80	.93	9.08	.79	7.36	.42	7.18	.29	5.72
	1.40	10.10	1.34	10.10	.92	9.05	.78	7.50	.42	7.40	.31	6.38
Average		10.29		9.94		9.08		7.26		7.16		5.96
3. Heated to 1200° F., cooled slowly	1.38	10.65	1.31	10.40	.93	9.23	.78	7.14	.43	7.25	.32	6.10
	1.35	10.15	1.32	9.85	.92	9.00	.79	7.75	.42	7.00	.32	5.90
	1.37	10.45	1.33	10.15	.93	8.92	.78	7.65	.43	6.97	.32	5.65
	1.36	10.28	1.32	9.80	.94	9.30	.78	7.66	.42	7.25	.32	6.98
	1.36	10.25	1.33	9.90	.95	9.00	.76	7.40	.43	6.50	.32	6.85
Average		10.35+		10.02		9.09		7.52		6.99+		6.30
4. Heated to 1200° F., held for 16 hrs., cooled slowly	1.37	10.20	1.34	10.70	.93	9.18	.78	8.16	.42	7.53	.32	6.80
	1.40	10.68	1.28	10.40	.95	9.95	.76	7.80	.43	7.58	.31	6.94
	1.38	10.85	1.31	10.45	.92	9.52	.79	8.16	.42	7.41	.32	6.70
	1.37	10.50	1.31	10.40	.93	9.36	.79	7.95	.42	7.66	.32	7.05
	1.39	10.50	1.32	10.37	.92	9.25	.77	7.67	.43	7.93	.30	6.46
Average		10.54+		10.46		9.45		7.95		7.62		6.79
5. Heated to 1300° F., Cooled slowly	1.36	10.35	1.36	9.91	.96	9.27	.80	8.05	.43	7.32	.31	6.84
	1.37	10.05	1.32	10.27	.94	9.18	.79	8.10	.42	7.34	.31	6.53
	1.37	10.35	1.33	10.20	.92	9.45	.77	7.90	.42	7.00	.31	6.87
	1.38	10.60	1.32	10.27	.92	9.20	.80	8.22	.42	6.28	.31	6.23
	1.35	10.55	1.31	10.30	.94	9.52	.78	7.85	.43	7.57	.31	6.45
Average		10.38		10.19		9.32		8.02		7.10		6.58
6. Heated to 1300° F., held for 16 hrs., cooled slowly	1.36	10.65	1.32	10.17	.95	9.15	.78	7.95	.42	7.23	.32	6.60
	1.36	10.46	1.29	10.34	.94	9.30	.79	8.25	.43	7.32	.32	6.32
	1.36	10.50	1.33	10.49	.93	9.45	.78	7.80	.43	6.67	.32	6.20
	1.37	10.44	1.33	10.07	.94	9.12	.77	8.48	.43	6.50	.31	6.52
	1.36	10.40	1.33	10.05	.94	9.42	.77	8.40	.43	7.75	.30	6.47
Average		10.49		10.22		9.29		8.18		7.09		6.42
7. Heated to 1400° F., cooled slowly	1.37	10.15	1.29	10.10	.94	9.25	.78	7.78	.43	7.23	.31	6.55
	1.38	10.04	1.33	10.10	.95	9.00	.78	7.38	.41	7.45	.31	6.40
	1.38	10.40	1.30	10.10	.91	8.99	.77	8.10	.43	7.05	.31	6.27
	1.38	10.40	1.31	9.60	.95	9.00	.79	7.50	.43	7.37	.31	6.84
	1.36	9.90	1.31	9.88	.94	8.70			.43	7.07	.31	6.40
Average		10.18		9.96		8.99		7.69		7.23		6.49
8. Heated to 1400° F., held for 16 hrs., cooled slowly	1.37	10.47	1.33	10.65	.95	9.05	.78	8.95	.43	6.35	.29	6.10
	1.39	10.49	1.33	10.71	.94	9.20	.78	8.25	.43	7.50	.31	6.03
	1.37	10.55	1.32	10.35	.94	8.50	.77	7.80	.43	7.30	.29	6.41
	1.37	10.50	1.28	10.10	.93	8.66			.42	7.58	.31	6.20
	1.37	10.55	1.32	10.40	.92	9.10			.42	7.28	.31	6.30
Average		10.51		10.44		8.90		8.33		7.20		6.21
Erichsen standard deep stamping steel	1.37	10.74	1.32	10.63	.93	9.67	.78	9.28	.43	8.12		
Tin plate steel.....									.43	7.65	.30	6.96

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Since practically all stampings are made cold, and phosphorus imparts cold-shortness to the steel, we may say that the lower the phosphorus, other things being equal, the better the steel for stamping. Here again, there may be an exception in that low phosphorus will not give the surface to the finished sheet, and as has already been mentioned, the surface is very important. Also the very low carbon or iron sheets do not stamp as well. No study as to the reason for this has been made as yet.

Laboratory Study of Annealing.

A steel having a carbon content about 0.10 per cent, would have a theoretical annealing temperature near 1620 deg. F. If a pile of sheets were heated to this temperature it would require a hammer and wedge to get them apart. Then too, because of the large mass of material and the slow rate at which it cools, there is ample time for grain growth. Hence, a test was made as follows. Six sheets were chosen with no special attention given to their selection other than to secure a considerable range in gage. The sheets were cut into 3½-inch squares and the squares from each sheet thoroughly shuffled together and marked. Five squares were taken from each sheet for each experiment, and the sheets were prepared for annealing by packing in a small metal box and covered with clay and fine sand, special effort being made to exclude the air. The box was then placed in a small electric furnace and two annealings were made at each of

the following temperatures: 1100, 1200, 1300, and 1400 deg. F. The first run in each case consisted simply in bringing the furnace to the desired temperature, and then cooling it slowly. The second run in each case was conducted in the same manner except

ANALYSIS OF STEEL—TABLE I

Steel	C.	Mn.	Phos.	Sul.
A	.12	.38	.011	.037
B	.12	.34	.011	.042
C	.12	.31	.017	.047
D	.10	.28	.015	.049
E	.13	.25	.054	.037
F	.14	.25	.089	.054

that when the desired temperature was reached it was maintained for a definite number of hours. The furnace was so regulated that the rise in temperature approximated 100 deg. F. per hour, and the cooling at about 50 deg. F. per hour. This heating and cooling

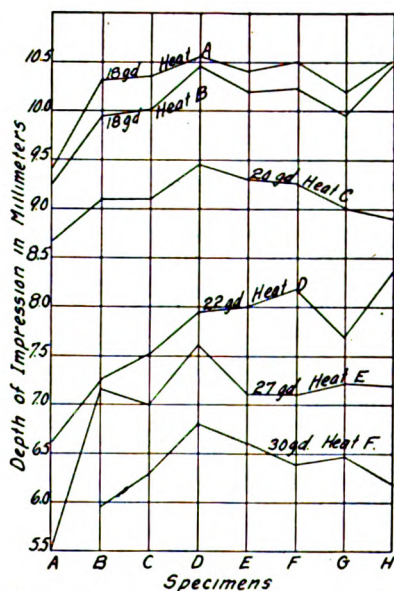


FIG. 6—Graphical representation of data of Table I. Specimen A, heated to 1100° F.; Specimen B, heated to 1100° F., held for 16 hrs.; Specimen C, heated to 1200° F.; Specimen D, heated to 1200° F., held for 16 hours; Specimen E, heated to 1300° F., held for 16 hrs.; Specimen F, heated to 1400° F.; Specimen G, heated to 1400° F., held for 16 hrs. All specimens cooled slowly after heating.

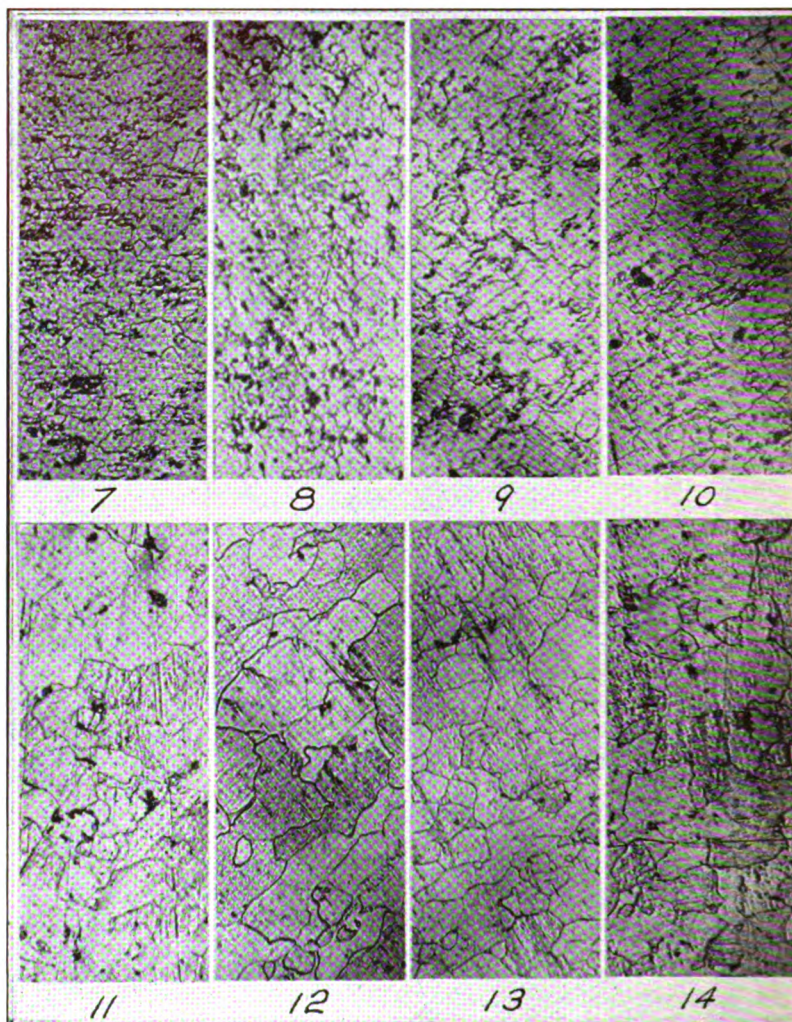


FIG. 7—Steel heated slowly to 1100 deg. F. Cooled slowly in furnace. FIG. 8—Steel heated slowly to 1100 deg. F., held at temperature 18 hrs. Cooled slowly in furnace. FIG. 9—Steel heated slowly to 1200 deg. F. Cooled slowly in furnace. FIG. 10—Steel heated slowly to 1200 deg. F. Held at temperature 15 hrs. Cooled slowly in furnace. FIG. 11—Steel heated slowly to 1300 deg. F. Cooled slowly in furnace. FIG. 12—Steel heated slowly to 1300 deg. F. Held at temperature 16 hrs. Cooled slowly in furnace. FIG. 13—Steel heated slowly to 1400 deg. F. Cooled slowly in furnace. FIG. 14—Steel heated slowly to 1400 deg. F. Held at temperature 16 hrs. Cooled slowly in furnace. Figs. 7-10 show a fairly fine grained structure, still showing the effect of straining. Figs. 11-14 show well formed but large grains. All photomicrographs X 100.

rate is very similar to the rate inside an annealing cover. As the tests annealed were so small it can be assumed that the temperature within the electric furnace would equal the actual temperature of the samples annealed.

After annealing, the squares were tested on an Erichsen machine and the results tabulated as in Table 1. A graphical representation of the same is shown in Fig. 6. Photomicrographs of this test are shown in Figs. 7 to 14, the first three showing some rolling strains while the latter ones (annealed at 1300 deg. F. or over) show grain growth. The Erichsen graph corroborates this and it seemed wise to carry on the experiment in the annealing room at 1200 to 1300 deg. F. This temperature would give as good

if not better results in stamping, and the sheets would open quite easily after annealing, since the lower temperature would be less harmful upon the furnace and covers, and since there was a considerable saving of fuel, this new practice reduced annealing costs without deteriorating the product, in fact in many cases improving it.

Mill Study—Cannon Ball Type Furnace.

In order to further carry out this test the temperature was taken on 10 heats, couples being placed inside the boxes, and test sheets being taken out after annealing at a distance of one to two inches from the couple. The furnace curves on Test 7, Table II are shown in Fig. 15. The maximum and minimum

TABLE II—ERICHSEN TEST—CANNON BALL TYPE FURNACE

Test No.	Position of Sheet in Box	Thickness in m.m.	Depth of impression in m.m. diagonally across sheet					Erichsen Per Cent	Box Average	Roof average during firing time.	Hours fired	Hours soaked	Total time in furnace.	Max. temp. at couple.	Tests higher on center or edge.
1.	A-Top	93	1000	1015	940	1000	1015	102.5	106.3	1834	13½	8	21½	1500	E
	C "	91	960	950	950	920	920	97.8						1450	
	E "	87	1000	1050	1090	1105	1070	111.7		Ave. Top—104.0%				1400	C
	B-Bot.	92	1100	1010	1080	1100	1100	111.6		Ave. Bot.—109.8%				1390	F
	D "	91	1046	1054	1080	1010	1010	108.0						1350	C
2.	A-Top	60	1025	980	963	1004	980	113.4	113.4		12	6	18	1440	E
3.		91	1000	1020	1075	1055	1035	107.5	111.8	1934	10½	11	21½	1560	C
		90	1020		1156		1100	113.8							C
4.	A-Top	80	975	1100	1110	1140	1142	116.9	112.3		10½	11	21½	1470	
	C "	89	1055	1030	1060	1030	1015	108.5						1460	C
	B-Bot.	86	1110	1110	1147	1158	1080	118.0		Ave. Top—112.7%				1390	C
	D "	83	975	1060	1060	1025	1065	110.1		Ave. Bot.—112.0%				1380	
	E "	79	990	1020	982	1025	1010	108.0						1360	E
5.	A-Top	80	1030	990	1010	975	974	106.7	109.3	1813	12	7	19	1480	
	C "	77	1040	1015	990	1050	995	110.0						1470	E
	E "	80	1065	1045	1053	1050	1070	113.1		Ave. Top—109.9%				1460	E
	B-Bot.	79	985	956	955	1020	1050	107.5		Ave. Bot.—107.5%					
6.	A-Top	87	1043	1020	1090	1050	1050	110.1	113.7	1814	12½	2	14½	1380	C
	E-Top	81	1075	1065	1030	1055	1070	113.8						1380	E
	B-Bot.	76	1020	1042	1030	1053	1080	113.3		Ave. Top—111.9%				1340	
	D "	80	1085	1115	1100	1140	1140	118.7		Ave. Bot.—114.8%				1320	
	F "	80	1070	1065	1062	1000	1055	112.4						1310	
7.	A-Top	81	970	925	995	960	960	102.7	109.5	1945	10	11	21	1390	C
	C "	79	970	1050	1012	1052	1018	109.5						1380	C
	E "	75	1015	1000	1010	1000	1010	109.5		Ave. Top—107.2%				1380	
	B-Bot.	80	1055	1075	1015	1046	905	109.0		Ave. Bot.—111.8%				1365	
	D "	78	1075	1000	1010	1031	1040	111.1						1360	E
	F "	77	1050	1085	1086	1046	1070	115.2						1350	C
8.	A-Top	80	975	965	965	950	970	103.3	107.5	1892	14	7½	21½	1475	E
	C "	77	1010	1028	1005	1025	1000	109.5						1460	
	E "	79	1042	1025	991	1005	1028	109.4		Ave. Top—107.4%				1450	C
	B-Bot.	80	923	975	985	982	995	104.0		Ave. Bot.—107.6%				1395	
	D "	83	1000	1060	1000	1036	987	107.9						1390	
	F "	82	1060	1034	1060	1050	1000	110.7						1385	C
9.	A-Top	81	1040	1030	1066	1005	1120	112.3	114.2	1975	16	6	22	1425	C
	C "	62	1028	1035	1095	1005	1000	117.6						1410	C
	B-Bot.	65	1040	1030	1054	1040	980	115.6		Ave. Top—114.9%				1380	C
	D "	61	1030	1030	1041	1060	935	116.6		Ave. Bot.—113.6%				1365	C
	E "	82	1020	1030	1057	1035	990	109.2						1350	C
10.	A-Top	78	985	980	970	985	1025	106.5	110.0	1850	8	8	16	1420	E
	C "	84	1140		1075	1060	1060	115.5		Ave. Top—111.0%				1415	
	B-Bot.	86	1055	1070	962	1038	986	107.0		Ave. Bot.—107.0%					E

Average for Sheets—110.4%. For Top Sheets—109.7%. For Bottom Sheets—111.0%.

Twelve edges ran higher than centers and 16 centers ran higher than edges.

Location of thermocouples shown in Fig. 17. Erichsen standard for stamping and folding sheets used.

temperature of the sheets on this particular heat is seen to be only 40 deg. F. In the study on bench type furnaces, it will be seen that this variation runs up to 300 deg. F. which makes it quite impossible to correctly anneal the whole charge. The material annealed in this test was 21 and 22-gage deep-stamping

nance burned 3542 pounds of coal to anneal 46,030 lbs. of sheets, while the hand-fired one burned 4195 lbs. on 52,55 lbs. of metal. An average of all tests showed about an equal coal consumption with labor considerably higher on the hand-fired type, therefore, the use of stokers was continued.

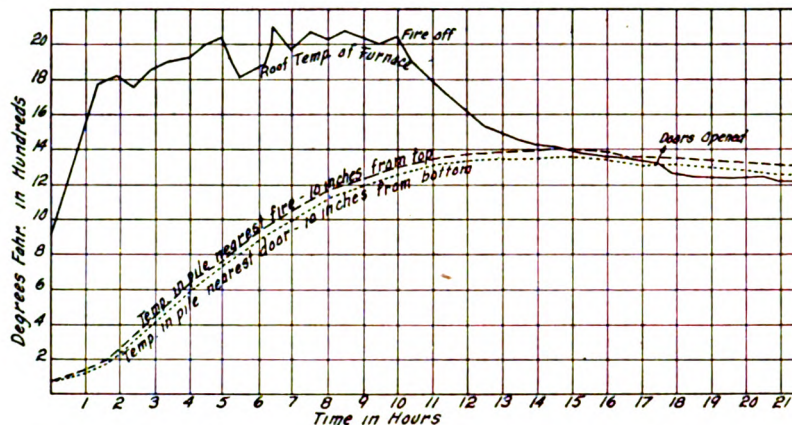


FIG. 17—Bench type—double stoker—side-fired furnace. Curves show roof temperature of the furnace, and the temperature of the boxes within the furnace. Position of couples shown in sketch. Couples B, D, E, and G would plot between C and H which are the maximum and minimum temperatures of the sheets. Data from Table II.

steel. It amounted to several hundred tons and was followed through the stamping operations. The breakage was so low that it verified the Erichsen test readings. On Test I, Table II, the temperatures were taken for information only; thereafter the annealing was done as far as possible to conform with the laboratory practice. It will be noted in Fig. 15 that the temperature continues to rise within the box after the fire is cut off—because the steel absorbs quite a lot of heat from the furnace itself—and it took two or three heats before this rise could be estimated.

Test 3, Table II, produced quite a number of red sheets although the temperature was very high, showing that red sheets do not necessarily mean that the steel was under-annealed. The test taken as a whole showed over-annealing—at least as far as the temperature was concerned. The top sheets (which received more heat than the bottom ones) gave a slightly lower Erichsen value and the middle of all sheets as compared to the edges gave a higher value. This would seem a very satisfactory check on the work. In Fig. 16 the furnace temperatures were plotted against the Erichsen percentage for each thermocouple, and clearly show a case of over-annealing. Table II is a record of all Erichsen tests, furnace temperatures, etc.

Hand Fired Versus Stoker Fired Furnaces.

It was thought that a considerable saving in coal could be made by firing these furnaces by hand in place of using a mechanical stoker. Numerous tests were run on two similarly built furnaces, differing only in the method of firing. It was found difficult to get equal weights of similar size sheets, covers and bottoms. The nearest approach to this is shown in Fig. 18. It was also deemed necessary in order to obtain a fair test, to fire at equal temperatures an equal length of time. The stoker-fired fur-

General Practice.

The majority of light gage, annealed sheets are pickled in sulphuric acid the solution averaging about 8 per cent by volume. If this operation is done after annealing, it is necessary to put the sheets through a dryer. If it is done before, the annealing furnace is in reality the drier. If the sheets are allowed to dry before they are covered and placed in the furnace, it is difficult to clean them. Therefore, it is advisable to charge them into a hot furnace at a temperature around 1000 deg. F. Slow firing would undoubtedly reduce the difference in temperature between the top and bottom sheets but it is perhaps more important to be able to clear them. Data on 16 heats are given in Table III. The average roof temperature during the firing time was 1590 deg. F. and was obtained in an average of 11½ hours. The soaking period (which does not figure in this average) was about 4 hours, after which the doors of the annealing furnace were opened and the boxes allowed to cool for three or four hours before removing. This delay seemed necessary because of the extreme heat which would work an unnecessary hardship on the men. It has since been found advisable to set a maximum roof temperature of 1800 deg. F., and by bringing the temperature up as rapidly as possible, the annealing time has not been lengthened. After removing from the furnace, the boxes are set on the floor to cool, and the covers are not raised for 30 hours.

Such material as tin plates or any full finish cold

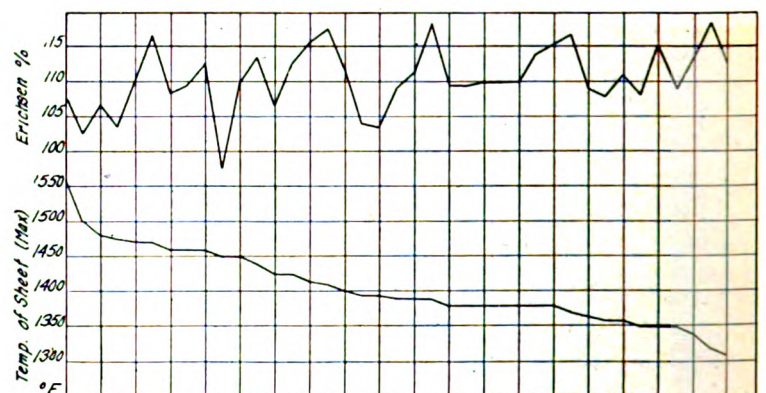


FIG. 18—Hand-fired versus stoker-fired furnace, showing the results obtained in a test to check the relative economy of each type of furnace. An average of all tests showed about an equal coal consumption on each furnace with labor considerably higher on the hand-fired type.

rolled stock must be reannealed after cold rolling to remove the strains of cold working. This second annealing operation is very important with light gage sheets, on account of the high phosphorus content. While it might be again said that the correct temperature would be 1620 deg. F., these sheets, now with a high polished surface will stock or weld together

much more easily, and since this added expense has been put upon them, loss from stickers will amount to considerably more in money. Experiments showed that on this class of material a temperature of over 1150 deg. F. would cause stickers, and that 1200 deg.

with a rust-resisting coating of oxide, which being in the form of Fe_3O_4 will vary from a light blue to a black. The material may be made as stove pipe, elbow, or high polished stock, with numerous grades between. Most of the methods for blueing take place during the annealing operations and are so closely related that a study of one must include a study of the other. The author has had experience with some 21 methods of obtaining a blued sheet by air, gas, steam and chemicals. The results, however, of these tests are not incorporated in this paper. These few words on blueing are merely to bring to the reader's attention the importance of annealing in the sheet steel industry.

Summary.

In summing up this paper the contents may be briefly classified into the following 14 points:

1. The most common type of annealing equipment is the box type furnace and annealing boxes.

TABLE III — TEMPERATURE DIFFERENCE DURING FIRING
All Bench Type Furnaces except No. 2. Rear-Fired unless specified.

Test	Inside Degrees Maximum	Temperature Fahr. Min.	Average roof Temp. during Firing	Temp. during time in Furnace	Firing Time	Soaking Time	Hours in Furnace	Diff. in Temp. Rise per Hr. Deg. Fahr.	Furnace No.
1.	1450	1050	1542	1459	13	3	16	85	400
2.	1400	1360	1846	1722	10	5	15	94	40
3.	1400	1290	1748	1628	9	6	15	94	110
4.	1340	1250	1565	1526	10	4	14	96	90
5.	1340	1280	1590	1552	11	3	14	96	60
6.	1300	1180	1567	1525	11½	4½	16	81	120
7.	1280	1170	1630	1563	9	4	13	100	110
8.	1275	1115	1485	1469	18	3	21	58	160
9.	1250	1210	1446	1431	16	2	18	70	40
10.	1250	1190	1478	1453	10	3	13	96	60
11.	1230	1180	1480	1413	10	3	13	95	50
12.	1220	1190	1525	1483	15	3	18	68	30
13.	1220	1180	1490	1458	14	2	14	87	40
14.	1200	1040	1706	1540	6	4	10	120	160
15.	1200	1020	1658	1536	11½	4½	16	75	180
16.	1200	1060	1596	1517	11½	5½	17	70	140
Average—	1295	1173	1585	1517	11.3	3¾	15.2	87	112

F. or over made them impossible to separate. Therefore, the second annealing is very light and it is impossible to remove all strains unless they were annealed in very thin packs, where their weight would not hold them close enough to stick. The roof temperature on cold rolled material does not run over 1400 deg. F. and the firing time about 8 hours.

Blue Annealing.

Heavy gage sheets (sheet mill material) are ordinarily spoken of as blue or box annealed. In this sense, blue annealed means the open annealing of a sheet in an open furnace, the sheet always having considerable scale on it. Blue annealing by the box method is quite a different thing, and as a large tonnage of light gage stock is marketed this way annealing is important. The purpose of blue annealing is to cover the surface of the sheets

2. The continuous box type furnace gives better heat control.

3. The continuous muffle type furnace should show a considerable saving in fuel due to the fact

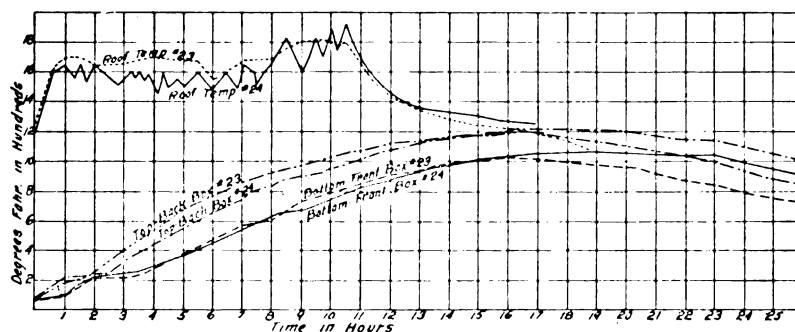


FIG. 16—Relation of maximum annealing temperature to stamping qualities of sheet steel as shown by the Erichsen test. Material was deep stamping steel annealed in a cannon ball furnace. Data from Table II.

that there would be no heat wasted in heating covers and bottoms.

4. Pyrometers on roof work require rare metal couples and the method of measuring temperature within the box is expensive and unsatisfactory.

5. Softness of the sheet does not necessarily mean good stamping quality.

6. A dirty surface will cause a well annealed sheet to break in stamping.

7. Steel should be as low as possible in sulphur and phosphorus with carbon and manganese within reasonable limits.

8. Grain growth must be prohibited even at the expense of incomplete removal of rolling strains.

9. Sticking is the result of a high annealing temperature, and frequently is accompanied by grain growth.

10. The heat distribution in the cannon ball furnace is good, but charging of the boxes is difficult.

11. The bench type furnace, while easy to charge, exhibits poor heat distribution.

12. Stoker-fired furnaces are as economical as hand-fired furnaces.

13. Bringing up the temperature as rapidly as possible will help to clear the sheets. The heat absorption of steel is a definite quantity with time and temperature the main factors.

A high furnace temperature only burns up the furnace and covers.

14. Deoxidizing and blueing are operations carried out on the steels while in a heated condition.

Note:

Because of the strains set up, cold rolled material is usually re-annealed, but even then the grain structure is poor, and the added stamping qualities certainly relate to the surface. The exact ratio of these two factors is not known, but the fact that they are important seems quite evident.

Electric Drive For Reversing Mill

By C. B. HUSTON*

THE recent electrification of a reversing skelp mill at the Youngstown plant of the Youngstown Sheet & Tube Co. marks an important step forward in the electrification of old steam-driven mills. This is the third mill at this plant on which a steam engine has been replaced by electric drive, this last one having been put into operation on June 18 of this year. In this particular case the engine had well served its purpose for many years of operation, but, since it was badly worn and somewhat too light for the service, a new drive had to be considered. With this improvement in view, the Youngstown Sheet & Tube Company decided to go a step farther and at the same time replace the old mill with an up-to-date one.

Skelp is the form of material from which welded pipes are made. It consists of what may be termed strip or plate, according to the width of the material. On this particular mill the skelp can be truly termed "plate." It is rolled from slabs from 3.5 in. to 5 in. thick by about 6 ft. long, varying in weight from 1,200 lb. to 3,700 lb., depending upon the width, which ranges from 15 in. to 45 in. The finished plate is reduced to a thickness depending upon the size of the pipe and the service for which it is intended. Materials as narrow as 7 in. or 8 in. may be rolled on this reversing mill, but it is not economical to use such a type of mill for the smaller sizes. Instead such stocks are rolled on some form of a continuous mill.

The mill, which was manufactured by the Mackintosh-Hemphill Company, Pittsburgh, is of the type commonly known as the two-high Universal reversing plate mill. There are two horizontal rolls between which the metal is squeezed for reducing the thickness from the slab to a plate stock. These rolls are each 30 in. in diameter. There are also four vertical rolls, two on each side of the horizontal rolls, by means of which the width of the plates is accurately

maintained. By removing these vertical rolls and replacing them with horizontal feed rolls, plates up to 72 in. in width may be rolled on this same mill. However, for the usual service this mill will not be operated in this manner.

The top horizontal roll is balanced by two hydraulic cylinders, and by means of a separate auxiliary motor the roll is raised or lowered. Further adjustment is obtained by a special equalizing device to change the elevation on one end of the roll alone, by means of which the surfaces of the two horizontal rolls may be kept parallel to each other. The side rolls are adjusted for movement in and out by an independent auxiliary motor driven mechanism. The driving of the vertical rolls, however, is from the same source, as the horizontal rolls, each being connected to the pinion stand to which the main motor itself is connected.

On each side of the mill there are table rolls for transferring the metal to and from the mill. These are likewise driven by separate auxiliary motors and are grouped on each side in what are termed front and rear live tables, approach and delivery tables.

In the operation of the mill there is very little manipulation of the metal required, it being necessary only to operate the "screw-down" to adjust the draft. make a slight adjustment in the setting of the vertical rolls and reverse the table-roll drive each time the piece is reversed to run it through the mill in the opposite direction. Thus the reversing service on the main drive must necessarily be extremely rapid in order to keep pace with the operation of the auxiliaries.

All equipment is served directly or indirectly by the three-phase alternating current lines. Thus the operation of the equipment is dependent only on the one source of power. The main mill motor is served by a three-unit flywheel motor generator. In this

(Continued on page 645)

*Power and Mining Engineering Department, General Electric Company.

New All Steel Electric Dredge

Converts the Same Amount of Coal into Eight Times as
Much Delivered Work

THIS boat marks a revolutionary advance in the design of commercial dredges for river service. It is made entirely of steel from its keel to the top of its smokestack. It is the largest river dredge of the drag-bucket line type, its buckets not being exceeded in size even by the huge gold dredges of the Pacific coast. It has a caterpillar type of bucket action which is a decided improvement over the usual stiff-frame type. It not only has an extraordinary capacity of almost 18,000 tons of sand and gravel per 12 hours run, but it enjoys the further distinction of having all its machinery electrically driven from its own self-contained power plant. The size of the boat is indicated by the fact that 93 tons of manganese castings and a full carload of electric wire were used in its construction. Quite impressive is the sight of the 33 huge dredging buckets continuously elevating and discharging their 21 cubic feet of contents at the rate of 12 to 24 each minute.

Dredging Conditions.

The Allegheny is stationed near Pittsburgh and was especially designed for its work of digging sand and gravel from the bed of the river, separating, screening and washing it, and delivering sand into barges on one side and gravel on the other. Dredging in the Pittsburgh district differs from that in other sections of the United States in that much gravel has to be dug up and then spouted back again, to obtain the needed sand. The dredge resembles a leviathan that digs up and swallows great quantities of sand and gravel, separates and washes the two, delivers the needed sand, then has to spout most of the unwanted gravel back into the river. But the Allegheny was especially designed for all-year operation under these grueling conditions.

Basic Idea of the Allegheny Design.

Its design involved a radical departure in that the dredge has a complete high-pressure condensing steam turbine power plant, delivering electric power to many motors scattered over the vessel, instead of several small boilers feeding many wasteful donkey engines. This idea of centralized power production and electrical distribution is not new, but it is new to dredge design, and produced epoch making results, as is evidenced by the fact that the new type Allegheny consumes practically the same amount of coal as the other Pittsburgh dredges, but delivers eight times as much sand! A cow that gave eight times the usual quantity of milk would be a remarkable cow!

The Owners.

The Allegheny is owned by the J. K. Davidson & Brother Sand Company, a concern which has been operating dredges in the Pittsburgh district for several years, but none of their other boats compare with the Allegheny in design, equipment or efficiency. The boat is commanded by Capt. C. H. Smith and was built under his supervision and that of Mr. Joseph Breslove, consulting engineer at the Oliver Building, Pittsburgh, Pa.

The Boilers.

The heart of any power plant is the boiler, which converts dead lumps of coal into live steam. The Allegheny employs two water-tube boilers of the Heine cross-drum marine type. These boilers have straight tubes and horizontal baffles arranged so that either the inside or outside of the tubes can be easily cleaned from the front and back of the boiler. The straight tubes and untrammelled water path result in a rapid circulation, giving a high capacity. These boilers are lined with fire brick inside a steel casing, which reduces radiation to a minimum. An equivalent Scotch marine installation would cost 50 per cent more, yet the Heine boilers weigh only two-thirds as much, and their capacious box-headers give an abundant reserve of hot water ready for emergency steam demands. Each of the two boilers develops 308 hp. at 250 lbs. per sq. in. pressure, and employs a semi-automatic stoker. Special treatment of the feed water is rendered unnecessary by the Heine internal mud drum.

Disposal of Ashes.

The ashes are discharged into a hopper under the boilers, from which they are sluiced out through openings in the bottom of the hull.

Induced Draft.

A variable induced draft to suit the boiler load is provided by a variable-speed motor-driven fan located in the base of the smoke-stack. This stack is made of steel and is supported on the steel breeching over the boilers. By using induced draft, the designers eliminated the high stack which would otherwise be needed for such large high-capacity boilers.

Vibrationless Generating Unit.

From the boiler room the steam flows to the adjacent turbine room which contains a 500-kw. Kerr steam turbine geared to a G. E. 250-volt d.c. generator. Direct current is preferable for easy control of the variable-speed motors necessary in dredge work. The operation of the entire generating unit is singularly free from vibration because it is installed on a special reinforced concrete mat tied into the deck beams and bulkheads. The turbine exhausts into a Worthington surface condenser, the condensate being pumped back into a feed water heater. The circulating water is pumped from the river to a settling basin, after which it passes through the condenser and back again to the river. The oil for the turbine circulates continuously and is automatically filtered by a Richardson Phoenix oil-filtration system.

Heated Feed Water.

All the exhaust steam from the auxiliaries is discharged into a Cochran open feed water heater, resulting in a feed water temperature which averages 200 deg. F. These auxiliaries include a steam supply pump, a steam feed pump, and a 25-kw. turbo-generator set used for lighting and repair work when the large unit is not in operation, and also for the cap-

stan, the barges, and the anchor hoists when the large unit is shut down.

Separated Electric Control.

At one side of the turbine room is a G. E. switchboard used only for the generating units and the main feeders, all the machinery being controlled separately from a distributing switchboard located in a pulpit housed in the forward part of the dredge. This pulpit is at such a height that the operator can overlook the main bucket line, the boom hoist, the rotating screens, and the sand and gravel elevators.

Metered Digging Operations.

The main digger motor and the boom-hoist motor are each controlled from separate panels in the pulpit or control room. Separate meters indicate the power taken by each machine and the total power for any given period. The power taken by the bucket-line or digger motor is recorded continuously by an Esterline curve-drawing wattmeter. The operator has thus before his eyes the power being taken by the bucket line, the rising buckets coming up to be dumped, and the submergence of the boom, from which he knows at all times the nature of the digging. The chart produced by the wattmeter may be used as a permanent record of the digging operation.

Locked Switch Room.

To gain ease of control and to minimize danger from accidents and interference, the large motors are controlled by master switches in the pulpit which operate through magnetic relays and switches located in a locked room beneath the pulpit and accessible only to the electrician.

Automatic Emergency Speed Control.

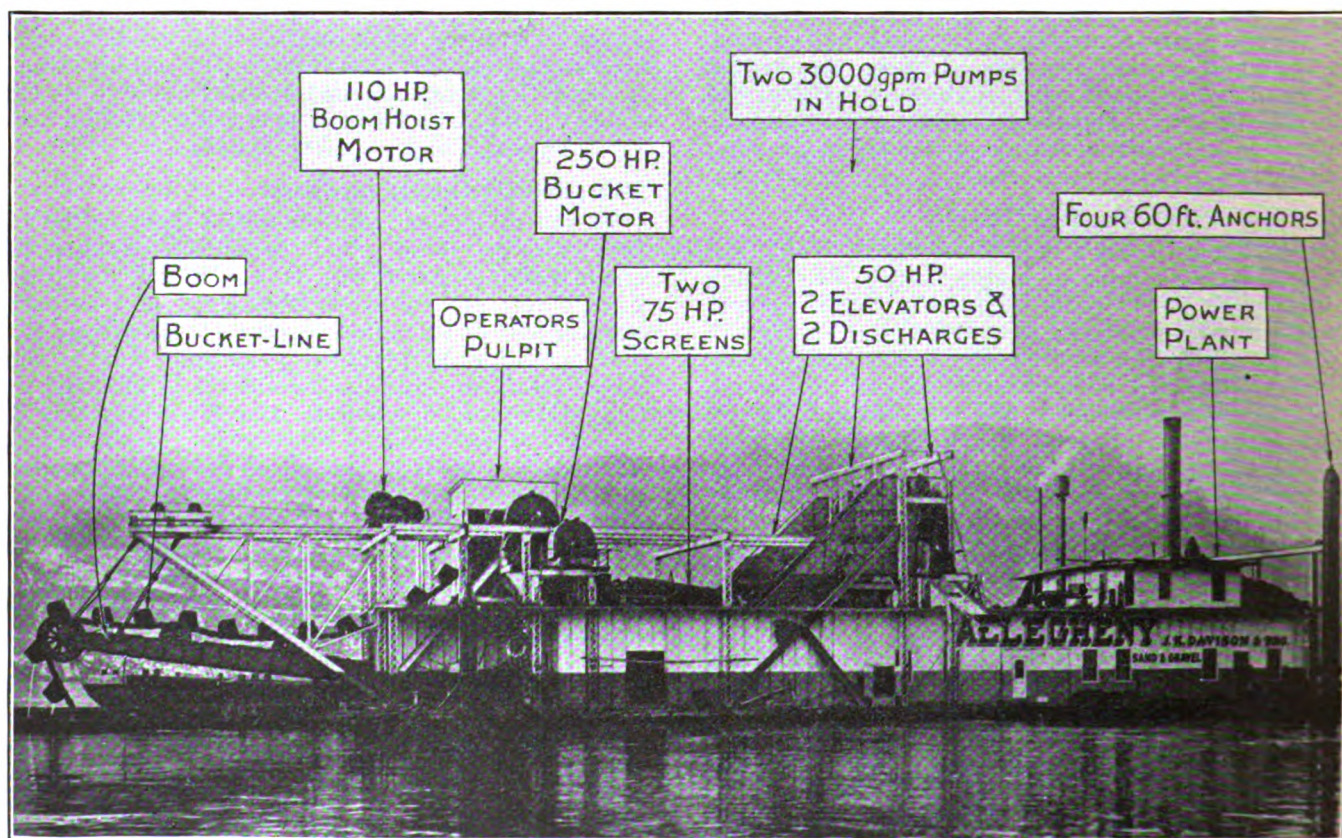
Special motor equipment for the digger motor enables the operator to follow closely the bucket-line operation and keep the load nearly constant. When the bucket-line becomes tangled or excessive "caving" occurs, this equipment automatically restores the full motor field, thereby reducing the speed and allowing sufficient time to clear the obstruction without opening the main circuit breaker. This feature has been unusually successful.

No Belts Used Anywhere.

There are no belts to be seen anywhere on the dredge Allegheny. The bucket-line is operated by the main digger motor of 250 hp. and the boom-hoist by a motor of 110 hp. The two roller-bearing revolving screens are driven by a 75-hp. motor through a silent chain and suitable gearing. They are supplied with wash water by two De Laval centrifugal pumps of 3,000 gal. per min. each. These pumps are driven by variable speed motors to meet the washing requirements of different kinds of material. They are controlled from the main operating pulpit and are located below the water line, obviating the necessity for priming.

Remote Control of Handling Apparatus.

The four 60-ft. anchor hoists were furnished by the Lidgerwood Manufacturing Company, their 15-hp. motors being of the enclosed mill type particularly adapted to this use. These motors are also dynamically braked, enabling the operator to adjust the anchors with safety and dispatch. Of the four capstans, three are driven by 7.5-hp. motors and one by steam. The material barges are moved by two motors of 15 hp. each.



The electrified dredge.

All of these motors are controlled from steel-encased stations placed where most accessible to the men handling the material. As the average dredge-operator knows little of electricity, this remote control greatly simplifies the manipulation and permits him to devote his entire attention to digging and handling the material. All electrical work is installed in weather-tight conduit and fittings. Particular effort was made to make the equipment as fool-proof as possible and a number of difficult problems of control were specially worked out for this new type of dredge. Most of the machinery was also especially designed.

Companies Supplying Equipment.

The speed reducers were made by the McIntosh-Hemphill Company of Pittsburgh. The buckets were built with Tisco manganese-steel lips and chains furnished by the Taylor-Wharton Iron & Steel Company and manufactured by the Goodman Engine & Machine Company of Pittsburgh, who also built the screens and secondary buckets. The Hummer pea-gravel screen was made by the W. S. Taylor Company of Cleveland, Ohio. All the steel cable was furnished by the A. Leschen & Sons Rope Company of St. Louis, Mo.

700-Ton Steel Barges.

The delivered material is removed by the Davison & Brother fleet of 24 steel barges. These are 135 feet long with 26-foot beams and have four water-tight bulkheads with bilge-pumps built in.

Continuous 800 Per Cent Service.

The dredge was placed in service in November, 1921, and has operated almost continuously since then for 10 to 12 hours per day. During this time the total boiler expense has been the negligible replacement of one tube. The buckets dredge from 10,000 to 12,000 tons of gravelly material from the river in a 10-hour day, or eight times as much as the other dredges engaged in this work. Yet the Allegheny's coal consumption is by daily records practically the same as for these smaller boats, so that eight times the material is being handled for the same fuel. Yet the crew of the Allegheny is only 10 men, where the smaller boats require seven.

Reason for Allegheny 800 Per Cent Service.

The electrical generation and distribution of power makes possible a uniform and continuous operation, ease of remote control, and the use of a central power plant of high fuel economy. The large steel barges of 700 tons capacity reduce the amount of labor for handling the discharged sand and gravel. But the most noteworthy feature of the dredge performance is the overall fuel economy which is 800 per cent better than that of any of the company's other dredges. The chief cause of this remarkable efficiency is twofold: First, efficient electric motors replace the many wasteful small non-condensing steam engines of the average dredge; second, the centralized power plant makes possible the use of efficient and reliable boilers of 308 hp. each, and these are of the Heine cross-drum marine type which is well adapted to this class of service.

Electric Drive of Reversing Mill

(Continued from page 642)

case there are two generators, each rated at 1,800 kw. and 650 volts d.c. The a.c. driving motor, which is the slip-ring type of induction motor, is rated at 2,500 hp. at 500 rpm. and 6,600 volts, three-phase, 25 cycles. The flywheel which forms a part of the set weighs 78,000 lbs., which, at the speed of 500 rpm., has a stored energy of 132,000 hp.-seconds. Load equalization is accomplished by means of a liquid slip regulator. Forced ventilation is a special feature of the flywheel set, two generators and the one induction motor being served by one air-conditioning equipment supplying 30,000 cu. ft. per minute.

In the design of the main mill motor as well as all the controlling apparatus the rapid reversing service of this mill was given special consideration. The motor was designed in two units, mounted on a common shaft, the armatures of which were made as small in diameter with a corresponding increase in length of stacking as is practicable in machines of this type. The advantage gained by such a design is low stored energy in the motor armatures. Thus the power and, correspondingly, the time required for reversing the unit are minimized. Not only does such a feature in the design help out on the reversals, but it also greatly influences the available capacity for acceleration with metal in the rolls. This fact is especially true in the operation of this reversing skelp mill on account of the long passes toward the end of each cycle of operation. It is impracticable to enter the metal at a speed desirable for rolling. Therefore the motor must accelerate the mill after the metal has entered, and to do so with excessive stored energy in the armatures would be a decided handicap in the operation of the electric drive.

The main-drive motor has a normal rating of 4,000 hp. at 80 rpm. to 135 rpm., which corresponds to 262,000 lb. torque at 1 ft. radius. It develops a maximum momentary torque of 592,000 lb. at 1 ft. radius at any speed from 0 rpm. to 80 rpm. From 80 rpm. to 135 rpm. the torque falls off in inverse proportion to the speed.

The control of the main mill motor is essentially a Ward-Leonard type combined with some motor field points. Both motors and generators are separately excited from a 250-volt exciter. The fields of the two motor units are connected in series and likewise the fields of the two generators. The speed of the motor up to base or full-field speed, which is 80 rpm., is governed by generator-field control and the speed from 80 rpm. to 135 rpm. is governed by motor-field control. The field circuits are handled directly by magnetic switches under the control of a master switch. Such a field control equipment for the operation of a reversing mill must provide the following features:

1. Selection of direction of rotation on mill motor.
2. Definite number of hand-controlled operating speeds.
3. Means of automatically obtaining the proper sequence from point to point.
4. Means of controlling rate of speed change, acceleration and retardation.
5. Means of protection against excessive loads, over-speed and full protection against improper manipulation by the operators.

CURRENT TECHNICAL DIGEST

Electron's Amazing Secrets

At the Bureau of Standards in Washington it is said that the outstanding scientific accomplishment of the decade is the increasing ability of man to reach into that infinitely tiny subdivision of matter, the atom, and take it apart. Theoretically, this possibility, now so near accomplishment, will make real the dream of the alchemists through all the ages—the transmutation of metals, the changing of dross lead into precious gold, and gold into more precious platinum.

The transmutation of metals may be seen in course of actual operation by means of an established process. It is now a theoretical actuality awaiting only improved methods to give it a place in commerce.

The forces released in the process of transmutation are stupendous, though as yet unmeasured. We are going to see practical application of them here and there. The curative properties of radium are due to the fact that it is in the process of transmutation, in changing from radium to lead. Its atom is breaking up. Those mysterious X-rays, with the aid of which doctors make photographs of broken bones or the coins swallowed by babies, come from the breaking up of atoms. The magniphone, which has recently come into use in "stepping up" the human voice so that it may be heard for hundreds of miles, is based upon power released by the breaking up of the atom.

In the most advanced realm of science the belief is held that, while the ability to change lead into gold is important, the development of the possibility of doing so, now on the eve of accomplishment, will result in benefit vastly more important to the human race.

Atoms as Targets.

To change one substance, one of the primary elements, into another, as, for instance, to change mercury into gold, you stand the mercury atoms up and shoot at them with a gun. This odd target practice may actually be witnessed in the laboratories of the Bureau of Standards. To be sure, the gun was neither an army rifle nor a farmer's shotgun. It was an electrical gun, and its bullets were electrons, which are the smallest things in the world. An electron is to a pin head as a pin head is to the world. It is the electron, flowing past in uncounted billions, that makes for example, the glow of the electric light.

Here is the way this gun and its targets are made ready for shooting. Take it that the laboratory marksman wants to make some gold. He knows that the element which is nearest to gold in the atomic scale is mercury. He chooses mercury for his experiment.

Mercury is a liquid. Like other liquids, or even solids, it may be converted into a gas. In the form of a gas any substance is greatly expanded. The atoms of which it is composed hang themselves out like a roomful of toy balloons. Mercury gas in this form, with its atoms exposed to attack, is placed in a tube. This

tube is so arranged that currents of electricity can be sent through it. When the trigger is pulled, great numbers of the electrons which make up the current go through the flocks of mercury-atom balloons. The balloons are not easy to puncture, but whenever one is burst in just the right way, that atom of mercury becomes an atom of gold. Transmutation has been accomplished.

To understand just how this change is brought about it is necessary to go a bit into the construction of the atom, a thing no more difficult to understand than the construction of a simple design in mosaic on your bathroom floor.

The chemistries we studied in school will soon be rendered out of date by these new investigations of the atom. Then we interested ourselves chiefly with a study of molecules. We knew, for instance, that H_2O was the chemical formula for water and that it meant that the molecule of water was composed of two atoms of hydrogen and one atom of oxygen. Having thus reached the atom, the scientists of that period knew that they had not come to the end of the road. But as pioneers they could see their way no further. Radium had not been discovered. They lacked its light to show them the ultimate goal.

What this decade has done since the epochal researches of Mme. Curie were given to the world is to take the atom apart, determine the method of its construction and determine the possibilities of making use of the knowledge obtained.

Chemists have long held to the theory that there are in nature certain so-called elements, materials that stand alone and are incapable of subdivision into component parts. Water is not an element, because it can be divided into hydrogen and oxygen. But both hydrogen and oxygen are elements, because there is nothing into which they can be subdivided. The same is true of lead, gold, platinum, sodium—of ninety-two elements in all. Everything that exists is built up of combinations of these ninety-two elements.

Back in 1914 a young British chemist, H. G. J. Moseley by name, worked out a theory of the existence of a relation between these ninety-two elements. His theory was that the simplest of the elements, hydrogen, had a relation to the next simplest, helium, the non-inflammable balloon gas. This had a similar relation to its next neighbor, and so on up to uranium, which stood at the top of the stairs. He drew these conclusions from the relations between X-ray impressions which these substances made upon photographic plates. The Kipling theory of likeness under the skin held with relation to these ninety-two fundamental elements. But this Englishman never knew the greatness of his theory, for he went away to war and was killed.

It is a demonstration of this theory that is just now revolutionizing the science of chemistry. Chemists have taken the atoms of enough of the elements apart to convince them that they all are built of the same substance.

that there is but one fundamental substance in the world, and that the only difference between any two of the ninety-two elements lies in the manner in which the particles of this substance are arranged in the make-up of the element atoms.

All atoms are alike in that they have a central portion, a core. To that core in the hydrogen atom there is attached a single particle, an electron. To that core in the helium atom are attached two electrons. To that core in the sodium atom are attached eleven electrons, in gold seventy-nine electrons, in radium eighty-eight and, finally in uranium ninety-two. Thus runs the gamut of all the elements that exist. The universe is built of electrons arranged in these ninety-two groups. The theory has been definitely proved. The number of electrons in each element has been worked out.

When this principle was established, what was more natural than that thought should be turned to taking electrons off or adding them to the atoms of certain elements, thereby changing them to other elements? There these atoms hung like bunches of grapes. If a single grape could be pulled off, a miracle would be worked. The task to be performed was set forth. Who would first learn how to accomplish it?

The advanced research chemist of the world have been laboring upon this problem for the past three or four years. In our own Bureau of Standards more has been done than at any other place. There all the work of all the scientists of the world has been brought together and digested, and upon it as a basis new experiments are built that may lead, any day, to discoveries reaching far toward solving the practical problems of human existence.

Dislodging Electrons.

The gun for shooting atoms is the primary mechanism in these experiments. Oddly, this gun existed and shot atoms for years before the scientist knew its possibilities. You, gentle reader, have beheld it at work if you have ever visited a photographer's workshop and seen his green mercury-tube lamp.

That tube is filled with mercury gas. The mercury atoms are held out as targets. The photographer turns on the electric current. It starts streams of electrons hurtling through that gas. One of those electrons hits a bullseye. It strikes one of the eighty grapes that compose the mercury atom bunch. If it can knock that grape clear out of place there will be but seventy-nine left and the atom will be that of gold. Transmutation from mercury to gold will have been accomplished.

But this eightieth electron is not quite dislodged. It is knocked out of place, but it slips back. So great is the agitation of thus loosening it from its place that the brilliant light of the photographer's green lamp results. The task of the scientists is to dislodge this atom actually and finally. It may be accomplished at any moment. When it is, when this atom is actually broken up, gold can be manufactured from the baser metals. When it is broken up nobody knows nor can conjecture as to the forces that will be released.

There are certain established facts, however, that may be used as a basis for surmise. There are certain atoms in existence today that are being broken up without the intervention of man. The chief among these is the radium atom. It is losing an electron. One of the grapes is being knocked out of the bunch. It is slowly changing itself from the most valuable of the elements to one of the least valuable, lead.

As the change takes place certain peculiar forces are released. Radium rays have been one of the miracles

of the last two decades. Only a few facts have been established as to the uses to which radium may be put. It is now employed chiefly in treating cancer. When radium is so plentiful that any scientist may have it for experimental purposes, other ways of harnessing it for usefulness will undoubtedly develop.

At the Bureau of Standards it is believed that the problem of battering atoms to pieces depends largely upon the development of the right sort of current to send through them. Possibly it is merely a matter of strength of current. Today it is possible to use a current of not more than 50,000 volts. If a current of a million volts were available the problem might be solved.

Recent British and Foreign Patents

Manufacture of iron. No. 191,764 British. R. Franchot and K. P. McElroy, Washington, U. S. A.

In a process for the manufacture of iron of the type in which a portion of the hot reducing gases is diverted from the blast furnace at a level below the usual top outlet, which portion may be cooled and returned in part to a higher zone of the furnace, the volume of gases so diverted is so adjusted in relation to the gases ascending the shaft that either a substantial net deposition of carbon is obtained within the shaft or the volume ratio of CO to CO₂ in the top exit gases is not greater than 250 deg. C. By regulating the proportions of the ascending and diverting gases, the temperature of the blast may be reduced, its volume increased to an amount exceeding 70 cubic feet per pound of carbon charged into the furnace, and the accumulation of salines in the hearth prevented, these being carried away by the diverted gases. The volume of gases diverted may be increased to lower the temperature and increase the ratio of CO₂ in the top gases and decreased to raise the temperature and decrease the CO₂ ratio. Some of the heat obtained from the diverted gases may be used to heat the air blast or for other purposes.

Conveyors. No. 191,822 British. Head, Wrightson & Company, Ltd., and R. S. Benson, Thornaby-on-Tees, and H. Clark, Westminster.

Two parallel jiggging conveyors are driven by two eccentrics, or cranks, set at an angle of 180 deg. to each other and fixed on two counter-shafts placed one behind the other, or on two counter-shafts placed in direct line with each other, or on a single counter-shaft. Cranks on the counter-shafts are connected by links to cranks on driving shafts. When the counter-shafts are in line, they are driven in a similar manner from a single driving shaft placed between them. When a single counter-shaft is used, it is driven by a single crank on a driving shaft.

Welding of metals. No. 191,910 British. Premier Electric Welding Company, Ltd., and J. H. Paterson, London.

In order to produce a reducing atmosphere, the coating of an iron or an iron alloy electrode for welding iron or steel contains the carbonate of a heavy metal or metals, the oxides of which have a comparatively low melting point, and carbon or carbonaceous material. The coating may comprise iron, nickel or manganese carbonate, and coke or anthracite. Mixtures are also described comprising chalk, ferrous, nickel or manganese carbonate, and lampblack, and ferrous and manganese carbonates and lampblack

respectively. The outer electrode coating, which may be colored, is made of precipitated chalk bound with glue or silicate of soda, and may contain a reducing agent such as dextrine.

Internal-combustion turbines. No. 192,100 British. F. F. Favata, Paris.

The working fluid of a turbine, for example, combustion products, expands in the presence of another quantity of the working fluid before passing to the turbine blades. Combustion products are ignited in a chamber containing previously ignited products and the mixture passes through a control valve to one or more chambers with similar valve controlled outlets and finally to the turbine blades. Regulation is obtained by throttling the exhaust. A crankpin and slot mechanism drives reciprocating compressor-pistons.

Welding of nickel. No. 192,193 British. Allen-Liversidge, Ltd., and C. Coulson-Smith, Westminster.

Nickels and alloys containing a high percentage of nickel are welded in the presence of carbon or carbonaceous material which produces a reducing atmosphere, reduces the rate of cooling, and prevents disintegration of substances. Bars of nickel and chamfered ends are welded together on a carbon block with a sodium silicate flux. The welded bar may be annealed, hammered, or rolled. The longitudinal seam of a tube is effected by the insertion of carbon rods. In lieu of the blowpipe the weld may be effected by carbon electrodes in direct contact with the metals or by carbon-covered electrodes.

Electric resistance. No. 192,383 British. Akt.-Ges. Kummeler & Matter, Aarau, Switzerland.

Silicon carbide is heated in silicon vapor, produced at about 3,000 deg. C., by heating a mixture of quartz and carbon, to form a resistance material having a small specific resistance compared with silicon carbide itself. The product, which is very hard, dense and non-crystalline, will stand very frequent and rapid variations of temperature within wide limits, and will withstand great mechanical strains when in an incandescent state. Bars, plates, etc., of silicon carbide may be subjected to the treatment, which may be varied to form the material in part only.

Reduction of ores. No. 192,426 British. J. H. Reid, Boston, U. S. A.

In a process for the reduction of ores and the production of gas, the ore is partially reduced by coking a finely-divided intimate mixture of ore, coal or the like and a flux, such as limestone, until the tarry constituents are removed and the coal completely coked and without material calcination or decomposition of the limestone. The coked mixture is charged in a hot condition into a blast furnace where it is smelted. Before coking the mixture comprises 100 parts ore, 80 parts bituminous coal, and 40 parts limestone, and after coking, 100 parts ore, 60 parts coke, and 40 parts practically unchanged limestone. The gases from the coking retorts and the blast furnace are conducted to a hydraulic main as well as the usual purifiers and scrubbers before passing to a gas holder.

Mixing of sand. No. 192,677 British. H. S. Simpson, Chicago, U. S. A.

In a foundry sand mixer of the edge runner type, the discharge door in the bottom of the pan is arranged towards the front of the machine and the operating handle, also placed to the front, actuates the door through bevel gear, a stop being provided on the dog which locks the handle to prevent the dog passing its

engaged position. The door overlaps two of the sectors of the removable pan lining.

Electric condensers. No. 192,744 British. G. S. Kemp, Southampton.

A condenser is built up of a number of metal plates with a distance piece of rubber secured to each plate. The distance pieces may comprise rings, tubes, or pads of rectangular section. Each plate may be provided with a pair of apertured lugs at opposite ends of a diameter, by means of which the plates may be threaded alternately on two pairs of stems or rods. In a form shown, the plates, with distance pieces in the form of tubular rings, are clamped between ebonite discs by a screw. The plates may be made of aluminum, zinc, tin or other metal, and may have wires soldered to them for connection as desired.

General Tripp Receives Highest Civilian Order from Japanese Government

(Continued from page 632.)

ferred to the United Electric Securities Company. With this company and the Thompson-Houston Electric Company he spent another seven years. In 1897 he transferred to Stone & Webster, engaged in the development of public utilities.

His entrance into financial affairs came through his selection in 1910 to head the reorganization committee of the Metropolitan Street Railway, which was then in receivership. Success in smoothing out the complicated financial situation of this company gave him a national reputation.

His connection with the Westinghouse Electric & Manufacturing Company began in 1911 on the death of Robert Mather, who had brought the company out of the wreck left by the panic of 1907. General Tripp was selected to succeed Mather as chairman of the Westinghouse board, the position he now occupies. In addition to this important position, he is a director in some 24 corporations, and a member of the Chamber of Commerce of the United States of America, the American Asiatic Association, and the Academy of Political Science in the City of New York.

Chile May Subsidize Steel Industry

A law for the encouragement and protection of the Chilean iron and steel industry has been presented to the Chilean Congress, Assistant Trade Commissioner W. E. Embry informs the Department of Commerce. The main features of the bill are: New companies which may be installed in the country for the manufacture of iron and steel will be conceded for a period of 10 years a premium of 15 gold pesos (18d) for each ton of pig iron produced and 15 pesos gold for each ton of steel produced, provided national materials are used, up to the amount of 30,000 tons of each of these products during the first two years of the existence of this law; 40,000 tons of each of the two products during the following two years; and up to 50,000 tons for each of the said products during the remaining six years of the life of the law.

For a period of 20 years an additional premium of five pesos of gold will be conceded for each ton of pig iron, or raw or semi-manufactured steel, which may be sold outside of the national market up to the amount of 20,000 tons of combined iron and steel.

Chile has deposits of iron ore and coal. In the first half of this year (1923) over half a million tons of iron ore were exported.

The POWER PLANT

Repairing Electrical Instruments*

Correct Adjustments and Good Mechanical Balance
Vital to Operation

TWO conditions exist when an indicating instrument is not in order. The instrument may not indicate at all, that is, it not only does not indicate properly, but the pointer does not move appreciably and there is no indication whatever. Or the instrument may indicate but not indicate properly.

When an electric measuring instrument fails to indicate, the trouble may be caused by one of four defects: (1) Lack of current or voltage; (2) open circuit in the instrument (3) short circuit of the measuring element and (4) mechanical difficulties. The first three are purely electrical defects and can be located by the proper use of additional instruments, while the fourth can be located usually by a close inspection.

For the mechanical troubles, a kit should be used. This contains necessary tools such as large and small pliers, wrenches, screw-drivers, soldering copper, eye-loop, magnet cleaner, tweezers, soldering flux, etc. The soldering flux is an important item as one of the first rules of instrument repairing is that fine wires or springs must never be soldered with any paste or flux containing the least acid. There are several acid-free compositions on the market such as "Tincol" or "Weldwell" which may be used, but an unexcelled paste is made by dissolving powdered rosin in alcohol and adding a little glycerin to prevent drying or caking. This must be used with thin wire-solder and a well-tinned soldering copper to produce perfect electrical connections. No acid or salammoniac and zinc chloride should be used.

Let us assume that a direct current voltmeter suddenly ceases to indicate. The first point is to see if it is caused by line trouble. Connect a portable standard voltmeter across the terminals of the non-operating voltmeter. Lack of indication denotes line trouble and the voltage should be tested nearer and nearer the bus or generator until the cause can be located. Loose connections or blown fuses often cause a lack of indication. If there is an external resistor in series with the voltmeter, connect the portable instrument across the line sides of the voltmeter and resistor to ascertain that the line voltage is on; then connect the voltmeter across the external resistor. Indication on both instruments shows an open circuit in the resistor; lack of indication shows open circuit in the voltmeter; indication of portable instrument alone shows short circuit or mechanical troubles in the voltmeter.

If a portable standard voltmeter is not available,

then low wattage lamps (5 or 10 watts) may be used to advantage, except that in some cases the lamps may not light because of high resistance in the voltmeter.

If the voltmeter shows open or short, this may further be confirmed by disconnecting one terminal and connecting the standard in series where lack of indication shows open circuit in either voltmeter or resistor and indication shows either "short" or mechanical troubles in the voltmeter.

"Opens" in the potential circuits of wattmeters, watt-hour meters, frequency meters, power factor meters, reactive factor meters, and synchronoscopes can be detected as shown above, provided the other circuits of the instruments are functioning correctly. "Shorts" may be determined in the above instruments except those where the total impedance of the potential circuit is in the measuring element, as in the watt hour meter. In this case, however, a mild short circuit does not cause non-registration but causes increased registration, while a large short circuit, eventually, causes a burn-out and open-circuit.

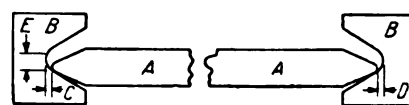


FIG. 1 — Diagram of shaft showing end-play and side-play.

Millivolt meters are tested exactly like voltmeters, except that a portable millivoltmeter should be used in the test. Self-contained ammeters should be tested with a similar range portable instrument, by connecting in parallel, to indicate the presence of current. If the ammeter is open in the main winding, this results in the completion of the circuit and main line current on the portable. Half line current on the portable indicates either electrical or mechanical trouble in the measuring element.

Let us assume that our original voltmeter has been proven intact electrically but still does not indicate. First, wipe all dust or dirt off the cover and then remove it carefully. Give the pointer a gentle push with a matchstick or toothpick to see if it is stuck (meter elements are usually alive and should be touched with caution). Possibly, it will stay wherever it is pushed and will not return freely to zero. Now disconnect the voltmeter and remove from the board.

One of the most important mechanical points in an electrical instrument is the correct adjustment of "end play." This is illustrated in Fig. 1 where enlarged

*Taken from chapter two in a "Handbook of Westinghouse Indicating Instruments" recently published by the Westinghouse Electric & Manufacturing Company.

and exaggerated views are shown of the shaft A with glass-hard, pointed ends and sapphire jewels B and B. The total distance C plus D that the shaft can move from end to end is called the "end-play" and the distance E, that the pivot can move from one side of the jewels to the other is called the "side-play." End-play and side-play are usually only a few thousandths of an inch and upon the correctness of this detail depends much on the success of the instrument. A most important rule of instrument repairing is, never screw the jewel-screws in until they clamp or pinch the moving element; even once may ruin the pivots.

Correctly designed jewels and pivots, usually, require adjustment of only "side-play" which is done as follows: Lay the instrument on its back and grasping the pointer gently but firmly with either tweezers or thumb and finger, wiggle it gently back and forth, meanwhile tightening the jewel screw with a screw-driver a fraction of a turn at a time until it wiggles only a few thousandths of an inch (about the width of a paper) and then holding the driver firmly, but not pressing down, tighten the jewel lock nut with a suitable wrench.

It may be superfluous to caution the repairman to ascertain that the pivots are actually in the polished

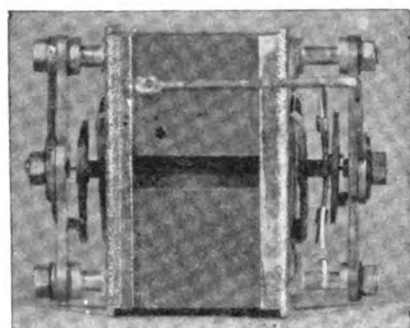


FIG. 2—End view of pole piece core assembly with springs and moving elements showing bearings and pivots.

recess in the jewel in making this adjustment and not in a crack between jewel and mount, but many pivots are ruined from this oversight.

The deflection of the induction type instrument varies slightly with frequency changes. This is not objectionable when the instruments are used on an ordinary power system. The small variations of frequency have no influence upon their reading. The latest designed instruments are of the dynamometer type, they read practically the same up to 133 cycles.

The best induction type instruments are the least affected by stray fields and static charges. The well designed iron case of dynamometer type meters will shield effectively the stray field encountered in general switchboard practice. The protective influence of the shield falls off as its magnetic density increases and disappears entirely at saturation.

With the induction type instrument, the effect is only noticeable when the stray field is exactly in synchronism with the current in the instrument. In such cases the distance between the instrument and the current-carrying bus should be current $\div$ 5 inches.

Instruments are also susceptible to external electrostatic effects. These effects usually manifest themselves by an attraction of the pointer toward the glass or case. Under certain conditions, by clearing and

rubbing the glass in the cover with a soft rag, the pointer of such an instrument may be moved a considerable distance up scale and remain there for some time.

Direct current instruments using permanent magnets, under normal conditions, have small errors due to external field, but may be permanently affected by such fields under short circuit conditions. The minimum distance between an instrument and a current carrying wire or bus bar should be current $\div$ 5 inches in order to protect the instrument.

Temperature errors in instruments are due to changes in physical dimensions and changes in electrical constants. It will be remembered that there are two active forces in an instrument the deflecting and the restraining forces. The deflecting force is the product of the actuating current, and the strength of the reacting element. If the temperature of an instrument increases, it may increase the resistance of its windings; this in turn lessens the current and results in a lower deflection. This is further aggravated by the weakening of the magnetic system due to heating. On the other hand, increased heat tends to weaken the restraining control spring, which tends to produce a higher reading. The correct balancing of these two opposite effects is one of the great problems of design and has been so nearly perfected that the actual error in the best instruments is well within the limits of commercial accuracy.

Mechanical changes are also possible due to heating; for instance, heating may distort a coil, or expand a shaft and mash the pivot ends. The first is overcome by a thorough seasoning of all parts, and the second by correctly designing the shaft so that it has the same coefficient of linear expansion as its supports.

Heating errors are produced from two sources: ambient temperature and self-heating. Over the first, the manufacturer has no control, other than to recommend that the instruments should not be used in places subjected to excessive temperatures, if at all avoidable. The second point is taken care of by means of external shunts and resistors, thus liberating the heat where it will cause no errors, instead, of in the instrument cases.

An amount of energy insufficient to cause heating alone will operate the moving elements of any fairly good instrument. It is, generally, the excess energy consumed in series resistors and shunts which causes the excess temperature. The errors due to mechanical causes are, probably, of greater importance than purely electrical errors, as the causes leading to them, reduce also the life of the instrument and increase the errors with use and time.

Other things being equal, the frictional error of an instrument is proportional to the ratio of torque to weight of the moving element.

Reprint No. 163 from Bulletin of the Bureau of Standards gives a classification of American Instruments according to their ratio of torque to weight of the moving element.

The weight of the movement, though very small gives a high pressure per unit of surface as the area of the pivot which has to carry the weight is extremely small. A lighter movement would decrease the pressure per unit of surface, reduce the wear of the pivots and jewels due to service and vibrations. A

lighter movement would have in service better sliding surfaces giving less friction and therefore showing better mechanical quality for same ratio of torque to weight of the moving element.

Success in instrument work comes only with absolute cleanliness, as the greatest enemy of an instrument is iron filings and dirt; sooner or later they find their way into the air gap and stop the moving element. To inspect the air gap of a direct current instrument, push a piece of white paper between base and element and then holding the instrument so that the light shines on the paper, look through the air gap as shown in Fig. 3. A magnifying glass may be used to advantage, and the least filing or hair or fuzz or dirt should be carefully removed. Iron filings can best be removed by using an iron wire or unbent paper clip and dirt and fuzz removed by using the tweezers or an ordinary chicken-wing feather. Other defects such as loose wire or parts out of alignment are easily discernable by a simple inspection and are, generally, repairable.

A good instrument should always have the moving element in good mechanical balance i. e., the pointer should indicate zero no matter in what position the instrument is turned. To secure this, the best instruments have threaded weights, although the principle of balancing is the same in all cases.

The first step is to lay the instrument flat on its back and set the pointer on zero. Then hold the instrument so that the pointer is horizontal and adjust the weight on opposite end of pointer so that it again indicates zero; then turning the instrument so the pointer is vertical, adjust either weight until it again indicates zero. Re-check and adjust the other positions if necessary. The instrument should now be in perfect mechanical balance.

After final inspection, the instrument may be re-tested and replaced on the switchboard.

After the instrument is repaired, it may be found that it is in serious error due to a variation in spring strength or magnets. Or it may be desired to change the capacity of the instrument by changing the spring strength. In either case, it is necessary to measure the "torque" or deflecting force of the instrument, usually expressed in "millimeter grams." Turn the instrument so that the full scale mark is in a horizontal line with the pivot and then hang a small weight on the pointer, until it deflects the pointer to full scale. Measure the distance from the center of the jewel to the center of the rider in "millimeter" using a pair of dividers if necessary and multiplying by the weight of the rider in "grams". Their product is the torque of the instrument in "millimeter grams". In the absence of metric standards, the torque may be calculated in "inch-ounces" using a copper wire table to obtain the weight of the wire used and reduce to "millimeter grams" by multiplying "inch-ounces" by the constant, 18.8.

Assume for example that a piece of No. 24 B. & S. G. copper wire one inch long balances at a distance of 2.25 inches out. From a wire table we learn that No. 24 copper has a weight of .001223 lbs. or .019568 oz. per foot; or .00163 oz. per inch, multiplying by 2.25 inches gives .003667 inch-ounce torque. Multiplying by 718.8 gives 2.635 millimeter grams torque.

If the scale deflection is 90 deg., and two springs are used, then the torque of one spring will be 1.317, for 90 degrees or 5.268 mmg. for 360 deg. and these are the terms in which the spring should be ordered from the manufacturer.

If it is desired to increase the instrument capacity 100 per cent then springs one-half as strong or 2.635 mmg. should be ordered or if it is desired to decrease the capacity to one-half, then springs twice as strong or 10.536 cmg. should be obtained.

This discussion of course refers only to instruments in which torque is proportional to the current or voltage applied. If a dynamometer type meter is used, the torque increases as the square of the current or voltage and in changing the capacity, the torque at the desired current or voltage calculated.

For instance, if we have a 5 ampere induction type instrument and wish to change the full scale capacity to 6 amperes due to an increase in load, assume that

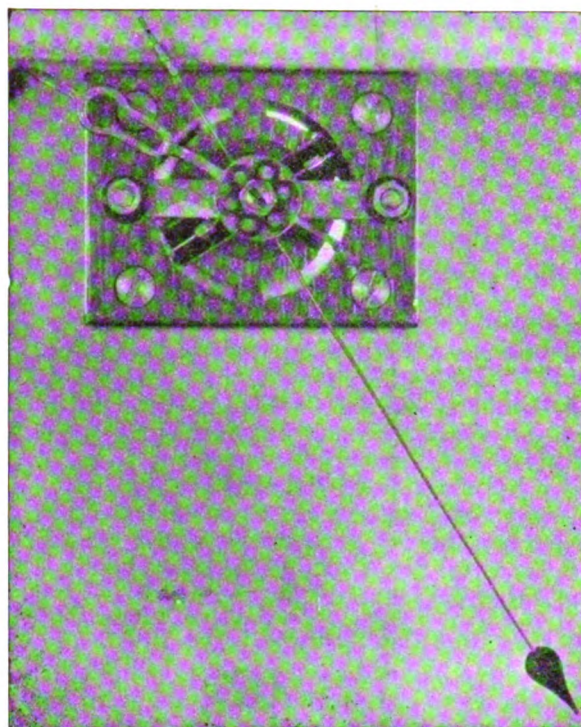


FIG. 3—Instrument in position for inspection of air gap.

the full scale torque (300 deg.) is 12 mmg., then the torque at 5 amperes would be

$$(5)^2 : (6)^2 = 12 : X$$

Solving this would give 17.3 mmg. But this is for 300 deg. Consequently the torque for one revolution, or 360 deg. would be

$$300 : 360 = 17.3 : X$$

Solving this, would give 20.7 mmg. which is the strength of spring to be ordered from the factory.

Care must be taken in changing capacities that the winding is not overloaded. If great changes are to be made, the main coil should be rewound. When lowering a capacity, care must be taken not to put a very weak spring in the instrument as the friction may cause very unsatisfactory results.

What Management Should Know

By ROBERT JUNE

Continuation of Part III, November Issue

The Krell CO₂ Recorder.

This instrument is closely allied to the Arndt gas-balance. A very delicate differential pressure-gauge is employed to determine the difference in weight, of measured volumes of the flue gas and air; and is attached to two columns of equal height, the one containing air and the other the sample of flue gas. A slightly inclined glass tube, filled with colored alcohol, is employed to record the pressure-gauge reading. The height of this thread of colored alcohol varies with the pressure, and by means of a scale marked in the percentages of CO₂ corresponding to certain pressures, the amount of this constituent of the flue gas can be read off.

The Haber-Loewe Refractometer.

This instrument depends for its action upon measurements of the "refractive index" of the mixed gases. The method is thus an optical one, and resembles the optical methods for determining temperatures. The refractometer consists of the following three parts: a prism, a telescope and a microscope. The prism, made of varnished metal, is provided with windows on opposite sides for the incident and reflected rays of light to enter and escape—and the gas to be tested flows through it, while the gas used for comparison flows through the casing. The observer sees in the field of vision when using this instrument, a scale which is partly illuminated and partly in darkness. The boundary of the dark zone will coincide with zero on the scale in pure air. In air containing 9 per cent CO₂ this boundary will coincide with 1.0 on the scale; and the line of demarcation between the light and dark zones will be still farther shifted, for higher percentages of CO₂. The instrument can be graduated, however, to yield the percentages of CO₂, or some other gas, directly by observation.

Checking Flue Gas Analysis.

The heat balance itself is always a good check on the accuracy of the results of a boiler test. The radiation and unaccounted for losses are always determined by difference. If this item is larger or smaller than the conditions would warrant, judging from experience, then an error has been made either in the observed or calculated data. This may be due to the gas sampling tube not being located properly or to some error in the analysis, either from a faulty instrument or technique.

In order to check out on the results of an actual test, Prof. Thomas G. Estep worked out the following concrete example based on data taken from the report of a boiler test:

ULTIMATE ANALYSIS OF DRY COAL

Carbon	77.00 per cent by weight
Hydrogen	5.00 per cent by weight
Oxygen	8.00 per cent by weight
Ash	10.00 per cent by weight

DRY FLUE GAS ANALYSIS

Carbon dioxide	12.00 per cent by volume
Oxygen	4.50 per cent by volume
Carbon monoxide	1.50 per cent by volume
Nitrogen	82.00 per cent by volume

The weight of the dry products of combustion per pound of dry coal is given by the equation:

$$\text{Weight dry products} = \frac{4 \text{ CO}_2 \text{ O}_2 700}{3 (\text{CO}_2 \text{ CO})} \times C.$$

$$\text{Weight of dry products} = \frac{4 \times 12 \ 4.5 \ 700}{3 (12 \ 1.5)} \times .77 = 14.31 \text{ pounds per pound coal.}$$

In order to find the theoretical weight of the air required to burn one pound of fuel it will be necessary to find the weight of carbon that is burned to carbon dioxide and to carbon monoxide. The assumed flue gas analysis can be converted to per cent by weight with the following result:

Carbon dioxide	17.51 per cent by weight
Oxygen	4.78 per cent by weight
Carbon monoxide	1.40 per cent by weight
Nitrogen	76.31 per cent by weight

Of the total weight of the dry products of combustion of one pound of dry coal, 1.4 per cent is car-

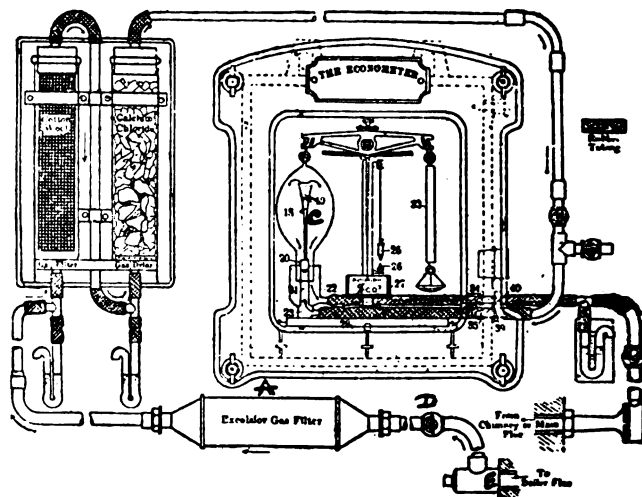


FIG. 7—The Arndt gas balance, in which differences by weight of gases are shown.

bon monoxide. Therefore, the weight of carbon monoxide per pound of fuel is $14.3 \times .014 = 0.2$ pounds. Since carbon is $12 \div 28$ of the weight of carbon monoxide, the weight of carbon burned to carbon monoxide is $0.2 \times \frac{12}{28} = .086$ pounds per pound of fuel. The carbon burned to carbon dioxide is $.77 - .086 = .684$ pounds per pound of fuel. The weight of air required theoretically to burn one pound of coal under the assumed conditions is as follows:

$$\begin{aligned} \text{Weight of air} &= 11.58C + 34.8 \left(H \frac{8}{8} \right) + 5.78C = \\ &= 11.58 \times .684 + 34.8 \left(.05 \frac{.08}{8} \right) + .086 = 9.81 \text{ pounds} \\ &\text{per pound of coal.} \end{aligned}$$

The air actually used under the assumed conditions is the weight of the dry products of combustion

(Continued on page 655)

TRADE NOTES

The American Rolling Mill Company has placed a contract with Arthur G. McKee & Company, Cleveland, for the installation of a McKee Patented Revolving Distributor on their "East" Blast Furnace at South Columbus, Ohio, their "West" furnace having been equipped with a distributor some years ago. This will make a total of 142 blast furnaces equipped with the McKee Revolving Top.

The Calorizing Company, Pittsburgh, announce the appointment of Mr. Roy Muir Ellis as New England Sales Manager with headquarters in Boston.

Mr. Ellis is a member of the A. S. M. E. and was for seven years connected with the Brown & Sharp Manufacturing Company, Providence, R. I., in various executive capacities. During the war he was general manager of the A. H. Fox Gun Company in charge of their various plants engaged in the production of small arms for the United States and British governments. Subsequent to this connection, Mr. Ellis was engaged in financing, reorganization and management work as Industrial Engineer for the Industrial Company, Boston, and for the last year or two in sales promotion work. He thus brings to his new work a wide experience in industrial matters and a practical knowledge of heat applications in manufacturing that should prove useful to the New England manufacturers with whom he will have contact in discussing applications of Calco Recuperators, Calorizing and Calite.

Jay C. Lahtrop, Cincinnati district representative of the Conveyors Corporation of America, 326 W. Madison Street, Chicago, Ill., has removed his office to 503 Neave Building, Cincinnati, Ohio.

The Newton Steel Company, Newton Falls, Ohio, is enlarging its steam plant to keep pace with the increased demands for steel, by the addition of a new model Westinghouse underfeed stoker which is equipped with steam operated dump grate and non-clinking extension sidewall tuyeres. A complete set of line shafting, with hangers, couplings, sprockets, and chains with chain guards are included. An Enberg steam engine with flywheel, throttling governor and sub-base for mounting has been purchased and will be direct connected through a coupling to the stoker line shafting. This engine is suitable for operating on steam pressures of 120-150 lb. guage at the inlet valve and with 10-15 lb. back pressure at the exhaust. Pittsburgh coal of about 13,500 Btu. will be used under this new 513 hp. Stirling boiler.

The Northern States Power Company, St. Paul, Minn., is extending the new Hi-Bridge Station by the addition of two extra long Westinghouse underfeed stokers.

This makes four of these extra long, latest design multiple retort underfeed stokers ordered for this plant. The extension agitating elements for these stokers are hollow and are supplied with air under pressure so that they are active fuel burning surfaces. These agitating grates are easily and quickly operated by steam power. Non-clinking extension sidewall tuyeres are placed on each side of the fuel bed and adjacent to the brickwork. Coal hoppers of extra large capacity are provided while revolution counters indicate the coal fed by the rams. Complete equipments of line shafting, hangers, chains, sprockets, chain guards and Alemite lubricators were specified by the engineers. Two new 1870 hp. B. & W. boilers were purchased for this new plant. An interesting feature of the installation is the fact that the equipment is so flexible that either Elkhorn, Pochontas or Southern Illinois screenings will be used without altering the stokers.

COMING MEETINGS

December 27-January 2—Seventy-fifth anniversary meeting American Association for the Advancement of Science at University of Cincinnati, Cincinnati, Ohio. Burton E. Livingston, Washington, D. C.

January 10-11—American Engineering Council of the F. A. E. S., Washington, D. C. L. W. Wallace, 24 Jackson Place, Washington, D. C.

December 5-8—Winter meeting, American Institute of Chemical Engineers, New Willard Hotel, Washington, D. C. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

February 4-8—Midwinter convention, American Institute of Electrical Engineers, Philadelphia, Pa. F. L. Hutchinson, 29 West Thirty-ninth Street, New York City.

January 22-25—Annual meeting, American Society of Heating and Ventilating Engineers, New York City. C. W. Obert, 25 West Thirty-ninth Street, New York City.

December 3-6—Annual meeting American Society of Mechanical Engineers, New York City. Calvin W. Rice, 29 West Thirty-ninth Street, New York City.

December 3-5—Nineteenth annual convention, American Society of Refrigerating Engineers, Hotel Astor, New York City. William H. Ross, 35 Warren Street, New York City.

January 18—Annual meeting, American Society of Safety Engineers, New York City. Genevieve S. Wood, 29 West Thirty-ninth Street, New York City.

January 22-24—Annual general meeting, Engineering Institute of Canada, Montreal, Que., and Ottawa, Ont. Fraser S.

Keith, 176 Mansfield Street, Montreal, Canada.

December 11-13—Convention of Kansas Engineering Society, Wichita, Kans. C. V. Waddington, Kansas Gas & Electric Company, Wichita, Kans.

December 12-16—Fourteenth annual convention, National Association of Practical Refrigerating Engineers, Memphis, Tenn. Ed. H. Fox, 5707 West Lake Street, Chicago, Ill.

December 3-8—Power show, National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City. Charles F. Roth, Room 1102, Grand Central Palace, New York City.

January 21-26—Annual convention, National Marine Engineers' Beneficial Association, Franklin Square Hotel, Washington, D. C. George A. Grubb, 313 Machinists' Bldg., Washington, D. C.

January 22-25—Annual meeting, Society of Automotive Engineers, General Motors Bldg., Detroit, Mich. Coker F. Clarkson, 29 West Thirty-ninth Street, New York City.

Coming Meetings of A. S. M. E. Local Sections

Dec. 14—Baltimore. Engineers' Club. Joint meeting with A. I. E. E. and M. I. T. Alumni Association. Subject, "The Engineer." Speaker, Dr. W. Stratton of M. I. T. Prof. J. C. Smallwood, secretary, Johns Hopkins University, Baltimore, Md.

December 19—Birmingham. At the Hillman Hotel. Subject, "Naval Aviation Training." Speaker, Capt. J. J. Raby, Commandant Naval Air Station, Pensacola. H. L. Freeman, secretary, Alabama Power Company, Brown, Marx Bldg., Birmingham, Ala.

December 10—Hartford. At Hartford Electric Light rooms. Subject, "Progress in Power Plant Development During the Past Few Years." Speaker, George A. Orrok. K. MacDonald, secretary, Terry Steam Turbine Company, Hartford, Conn.

December 18—New Haven. At Mason Laboratory, Yale. Subject, "Impressions of Japan." Speaker, Elmer A. Sperry, president Sperry Gyroscope Company. Prof. S. W. Dudley, secretary, 400 Temple Street, New Haven, Conn.

December 19—Philadelphia. At Engineers' Club. Subject, "Application of Materials Handling Formula." H. W. Jackson, secretary, Hess-Bright Manufacturing Company, Front Street and Erie Avenue, Philadelphia, Pa.

December 14—Providence. At Providence Engineering Society. Subject, "Appraisals and Depreciation." Speaker, H. Eugene Sypesi, of Sypesi Industrial Organization. A. C. Dickerman, secretary, Central Engineering and Construction Company, Slater Trust Bldg., Pawtucket, R. I.)



T. Holland Nelson, recently placed in charge of the works at Titusville, Pa., of the Cyclops Steel Company, was formerly steel works manager for Henry Disston & Sons, Inc., Philadelphia. Mr. Nelson was born in Sheffield, Eng., and educated at Sheffield University. For several years he was employed by Thos. Firth & Sons, Ltd., Sheffield, finally becoming assistant to Harry Brearley, metallurgist and developer of stainless steel. Mr. Nelson came to the United States in 1911 and joined the Simonds Manufacturing Company, later becoming connected with Henry Disston & Sons, Inc. During the war he was managing director of Peter Stubs, Ltd., in the manufacture of munitions. He is a member of the American Iron and Steel Institute, Iron and Steel Institute, American Society for Steel Treating and the Sheffield Metallurgical Society.

R. B. Mellon of Pittsburgh has been elected a director of the Crucible Steel Company of America. He succeeds Duane Armstrong, resigned.

Robert Geddis, general manager of sales in the western district for Jones & Laughlin Steel Corporation, is making a tour of the Pacific coast in the interest of his company.

R. R. Stevenson, New Kensington, Pa., recently made general manager of the New Kensington works of the United States Aluminum Company, was formerly assistant superintendent of the plant. He has been connected with the Aluminum company since 1909.

Thomas Daugherty, recently made manager of the sheet department of the Central Steel Company, Massillon, Ohio, was for the past few years connected with the claim department of the Sharon Steel Hoop Company, Sharon, Pa. He

assumed his new duties November 19.

F. N. Finger, who for 10 years prior to 1918 was associated with the Carnegie Steel Company, has resigned as credit manager of the Guaranty Trust Company of New York to become vice president and managing director of Edward T. Ward's Sons, Inc., handling specialty steel products with headquarters in Newark, N. J.

Moses Taylor Pyne, Jr., president of the Steel Equipment Corporation, Avenel, N. J., son of the late Moses Taylor Pyne, died November 17 at his home in New York, following a six weeks' illness. Mr. Pyne was 39 years of age and was graduated from Princeton University in 1908. He was a director in a number of railroads and corporations.

Louis J. Campbell, president of the Atlas Steel Corporation, Dunkirk, N. Y., is seriously ill in New York, following a recent nervous breakdown. Several days ago Mr. Campbell underwent an operation in which one of his legs was amputated eight inches below the knee. The operation was necessitated by the effects of a recent stroke of paralysis. Since then Mr. Campbell has progressed rapidly toward recovery.

Harbor Mitchell, who resigned recently as vice president and general manager of the American Foundry & Construction Company, Pittsburgh, has been appointed assistant to Mr. Floersheim of B. Floersheim & Company, piping engineers and contractors, Pittsburgh. Mr. Mitchell is a graduate in mechanical engineering from West Virginia University and has had 15 years' experience in the selling and manufacture of piping systems.

W. E. Schmid, mechanical engineer, Combustion Engineering Corporation,

has been assigned to the branch office in Paris, the Societe Anonyme des Foyers Automatiques.

W. J. Mackenzie, metallurgist, Interstate Iron & Steel Company, Chicago, addressed a combined meeting of the Cincinnati Engineers' Club and the American Society for Steel Treating on Thursday evening, November 15. The meeting was preceded by a dinner.

Frederick W. Henrici, assistant engineer of the erecting department, American Bridge Company, Pittsburgh, was the speaker at a joint meeting of the civil section, Engineers Society of Western Pennsylvania, and the Pittsburgh section, American Society of Civil Engineers, at the Wm. Penn Hotel, Pittsburgh, on Tuesday evening, November 13. He described the erection of the Southern Railroad bridge over the Ohio River at Cincinnati.

Charles N. Ring, formerly identified with the Ohio Steel Foundry Company, Lima, Ohio, has been appointed manager of the Allied Steel Castings Company, West Harvey, Ill.

E. P. Mathewson of New York, president American Institute of Mining and Metallurgical Engineers, has been elected representative fellow of McGill University, Montreal, for countries outside of Canada and Newfoundland. He will serve for three years and becomes a member of the McGill Corporation. Mr. Mathewson was born in Montreal in 1864 and received from McGill the degree of Bachelor of Science in Mining in 1885.

Harry J. Rothrock has been appointed assistant foundry superintendent of the Deemer Steel Casting Company of New Castle, Del. During the last four years he has been with Taylor-Wharton Co.

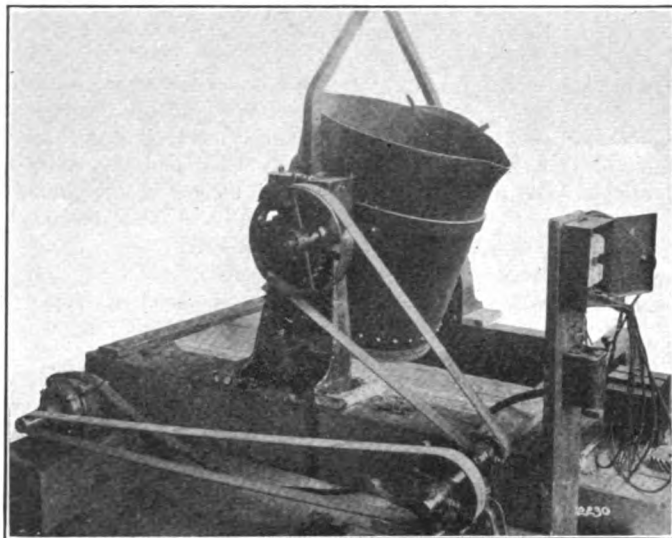
WITH THE EQUIPMENT MANUFACTURERS

Test of Ladle Gearing at Whiting Corporation Plant

An 8,000-lb. capacity crane ladle was set in a pair of standards arranged so that ladle could revolve continuously in either direction, as shown in accompanying photo. A standard helical-worm gear bracket was mounted on ladle trunnion, hand wheel removed and 18-in. pulley put on in its place. A 2-hp. motor was set to drive the ladle through jack shaft so that hand wheel shaft was running approximately 94 rpm.

Ratio of gearing was $58 \frac{2}{7}$ to 1, the ladle revolving 1.6 rpm. A revolution counter was mounted on the idler trunnion of the ladle and an Esterline recording wattmeter was mounted in the motor circuit, showing graphically the power required to drive the ladle at all times.

A counterweight consisting of round steel plates weighing 500 lbs. was attached to the bottom of the ladle, this



weight being sufficient to put a load on the gearing equivalent to the maximum load encountered while using this same size ladle in the foundry.

During the test the maximum power was required only at one point during the revolution of the ladle, when the counterweight was at its greatest horizontal distance from the center of the trunnion.

Starting with the ladle in vertical position with counterweight at the bottom and turning the ladle 90 deg. gave us approximately the same amount of work for the gearing to perform as if the ladle had been used to pour its capacity of molten metal. On this basis, one complete revolution of the ladle in the test is equivalent to using the ladle twice in the foundry.

After 6,000 revolutions of the ladle (equivalent to about 10 years service in the average foundry), the bronze bushings in the bracket were carefully examined and found worn perfectly smooth, and only a very few thousandths of an inch loose. It should be noted here that the pressure on the bearings of the hand wheel shaft, due to the weight of the pulley and the tension of the belt, was several times as great as would occur in ordinary operation. The power input to the

motor averaged 0.8 kw. at the peak and 0.2 kw. while counterweight was traveling downward.

Gredag 314 was used throughout the test and proved to be a very satisfactory lubricant for both gears and bearings.

As a result of this test, we believe that the standard Whiting helical-worm gearing should outlast the ladles to which it is attached, barring accident and assuming ordinary attention to lubrication.

What Management Should Know

(Continued from page 652)

minus the weight of the carbon in the fuel plus the weight of the oxygen supplied to burn the hydrogen. Thus

$$\text{Actual weight of air} = 14.31 - .77 + 8 \left(.05 \frac{.08}{8} \right) = 13.86 \text{ pounds per pound of coal.}$$

The apparent excess air is $13.86 - 9.81 = 4.05$ pounds.

Now, if the assumed flue gas analysis is correct for the given coal analysis, it should check with the flue gas analysis calculated from the above excess air. To calculate this flue gas analysis, per cent by volume, the following results:

	Volume of	Cu. Ft.
Carbon dioxide	$= .684 \times 3.67 \times 8.15$	$= 20.45$
Carbon monoxide	$= .086 \times 2.33 \times 12.80$	$= 2.57$
Oxygen	$= 4.05 \times .23 \times 11.21$	$= 10.46$
Nitrogen	$= 13.86 \times .77 \times 12.77$	$= \frac{136.00}{169.48}$
Carbon dioxide	$= \frac{20.45}{169.48}$	$= 12.08\% \text{ by volume.}$
Oxygen	$= \frac{10.46}{169.48}$	$= 6.17\% \text{ by volume.}$
Carbon monoxide	$= \frac{2.57}{169.48}$	$= 1.52\% \text{ by volume.}$
Nitrogen	$= \frac{136.00}{169.48}$	$= 80.23\% \text{ by volume.}$

Since this analysis does not agree with the assumed analysis, it is evident that the latter is not correct or at least it cannot be used with the given coal analysis.

"How to Sell More Gas and Oil," is the name of an attractive 24-page booklet recently released by S. F. Bowser & Company, Inc. The keynote of the article may be summarized in a single line, "Personality and courtesy are the two things that sell more gasoline and oil." So true is this, not only in selling gas and oil, but also in selling anything else, and so necessary is this formula in the conduct of any business, great or small, that a careful reading of the Bowser "watchword" will well repay most anyone.

Some Pointers on By-Product Coke Oven Operations

ACID-RAISING APPLIANCES

Extensive use is now being made of high-silicon irons in acid conveying plant, but while the extreme hardness of the material is of advantage in many pieces of apparatus, it necessitates special designs when parts have to be machined. Thus, in the earlier design of acid-resisting centrifugal pumps made by Messrs. Meldrums, Ltd., Timperley, Manchester, the castings were split down the center of the volute, resulting, of course, in the delivery branch being divided. In their new pattern of pump, however, the volute and delivery branch are in one casting, and a separate cover carrying the suction branch is bolted to it. This enables the whirlpool chamber and volute to be made of a more uniform shape, and for a given speed and diameter of impeller they are able to get considerably higher lifts than with any of their previous designs.

In spite of the difficulties of manufacture of pumps made in Meldrum metal, these results compare favorably with a pump made in cast iron or bronze. The firm's acid pumps have been running for years on searching acids and liquors and, we are informed, show extremely little wear. The metal is entirely proof against sulphuric, nitric, and acetic acids of any strength or temperature, and has, it is stated, been used for very searching copper and chlorine liquors which no other metal or material is able to withstand.

Another method of raising acids is by means of the automatic compressed-air elevator. This type of apparatus finds favor in acid plants, as high lifts are obtainable by a corresponding increase in air pressure. The elevator works automatically, i. e., when there is no acid running into the vessel, no air is used. The vessel works on the following principle: As the acid rises in the vessel it lifts a float which operates the air-valve. As soon as the air enters the vessel it closes the inlet valve, and also closes the air bend valve. The vessel is now sealed, and the air pressure forces the acid out of the delivery pipe at the bottom of the reservoir. The air follows the acid up the pipe, and the pressure is at once reduced and the float drops, closing the air-valve. The inlet valve again opens, and a fresh supply of acid enters the vessel. The acid can be allowed to trickle in quite slowly, and the apparatus works with certainty as soon as the definite level of the acid in relation to the float is reached. All internal parts of the

vessel, valves, etc., are made of Meldrum acid-resisting metal.

Messrs. Meldrum, Ltd., are also developing a further improvement in compressed air elevators. In this case the acid is operated by a plunger, and the acid does not come in contact with the acid. This type has the advantage that it is economical in air, as no more air is used than displaces the acid from the vessel. It works automatically, but requires a reservoir from which to draw, as it keeps in operation whether the acid is being pumped or not; consequently it should be used where there is a continuous supply of acid to draw from.

As a cheap means of raising acids the steam-jet apparatus is useful in many cases. In this apparatus the steam dilutes the acid to some extent, and this is frequently, of course, a disadvantage; in other cases it does not matter.

These four types of apparatus for raising acids will show the extent of developments in this direction, and there is no case where one or other of our apparatus would not be suitable. In the case of the pump and automatic acid elevator, these can be manufactured with regulus-metal bodies and Meldrum-metal moving parts.

Prepared fuels offer the simplest and most practical possibility for reducing smoke in domestic furnaces. Of these, coke is probably the most feasible. The use of coke fuel in residences not only helps to eliminate domestic smoke, as coke can be burned smokelessly in ordinary furnaces at all times, but aids the conservation of natural resources. The probability is that some time a large proportion of the coal used for residence purposes will be carbonized; thus valuable by-products will be recovered before the fuel is burned.

High pressure plants that produce power for miscellaneous manufacturing establishments are the chief sources of industrial smoke. Most of these plants are hand-fired and consist of comparatively small units, approximately 150 hp. each. Since they make so much of the smoke of the average city, smokers of this class have received most attention, and engineering information on such plants is more widely distributed and more thoroughly standardized than other literature dealing with smoke abatement.

Stoker-fired plants have perhaps been most successful in smoke abatement. The boiler units are generally of large size,

are equipped with mechanical stokers, and have been carefully designed by competent engineers. In addition, these plants are under constant supervision by skilled engineers, and firemen are always in attendance.

Locomotive smoke has seemed most difficult to control, but many cities in the Middle West have attempted to solve this problem with more encouraging results than were at first supposed to be possible. In the past ten years standardized equipment has been designed to reduce the discharge of smoke from locomotives. This equipment includes multiple-tip blowers, quick-opening blower valves, and induction tubes in the sides of the fire box to supply the air necessary for complete combustion. Such equipment is simple, is easily added by ordinary boiler makers, and has been discussed in detail in the proceedings of the various railway associations.

Success in smoke abatement depends largely on the administration of existing laws. Perhaps the most important consideration is the type of man for administering a smoke ordinance. It seems wise to have an engineer in charge who is familiar with boilers and furnaces and who can understand the engineering problems that will arise when the ordinance is put into effect.

The results of this investigation have been embodied in a report designed to make the various technical problems necessarily associated with the subject of smoke abatement thoroughly intelligible to the non-technical reader. Copies of this report, Technical Paper No. 273, may be obtained from the Department of the Interior, Bureau of Mines, Washington, D. C.

Effect of Sulphur on Forging Steels

A series of tests on steels furnished by Jones & Laughlin is being conducted under the immediate supervision of the committee. Tests will be made at the Watertown Arsenal.

Seven heats of basic open hearth steel were accepted by the committee as follows: Carbon, 0.45-0.57; manganese, 0.54-0.69; phosphorus, 0.011-0.056; and sulphur contents of 0.028, 0.032, 0.042, 0.045, 0.059, 0.073 and 0.101 per cent. The sulphur is "residual" sulphur.

The complete history of each heat of steel is known. The sulphur was introduced in the form of high-sulphur pig and scrap.

NEWS OF THE PLANTS

The Youngstown Sheet & Tube Company, Youngstown, Ohio, is perfecting plans for the construction of a new blast furnace at the works of its recently acquired subsidiary organization, the Steel & Tube Company of America, Indiana Harbor, Ind. The new unit will have a rated capacity of 600 tons, or approximately the size of the blast furnace at the Warren, Ohio, plant of the Trumbull-Cliffs Furnace Company, said to be the largest in the world. It is expected to commence foundations at an early date and have the furnace ready for service during the coming year. The company will also construct two new butt-weld pipe mills at this same works, making a total of 22 such mill units at the plants at Indiana Harbor and Youngstown, respectively.

The American Puddled Iron Company, Youngstown, Ohio, is making ready for initial operations on a curtailed basis at its new local plant. One mechanical puddling unit is practically completed, while three other such units will be installed as soon as the first is in service. The works will have a rated output of 250 tons of puddled iron per day, with a rolling capacity to close to 1,000 tons daily. When completed, it will represent an investment of close to \$1,750,000 including buildings and machinery.

The Atlas Steel Corporation, Dunkirk, N. Y., has disposed of an additional stock issue of \$3,000,000, and out of this fund will use approximately \$400,000, for extensions and improvements in its local mill, including the installation of additional machinery for increased output. The company has recently closed its mill at Charleroi, Pa., and the majority of the machinery at this works will be utilized at the Dunkirk plant. The company purposes to discontinue operations permanently at Charleroi. L. J. Campbell is president of the company, which comprises a merger between the Electric Alloy Steel Company, Youngstown, Ohio, and the Atlas Crucible Steel Company, Dunkirk.

The Anchor Drawn Steel Company, Farmers' Bank Building, Pittsburgh, Pa., recently organized, has preliminary plans under advisement for the erection of a new local mill on site to be selected in this district. It is purposed to commence work at an early date. The initial plant will be equipped for the manufacture of cold-drawn steel products, as well as steel drill rods and kindred specialties, and is reported to be estimated to cost in excess of \$200,000, with machinery. The new com-

pany is headed by D. R. Wilson, formerly vice-president and treasurer of the Carbon Steel Company, and at one time was connected with the Kittanning Iron & Steel Manufacturing Company, as treasurer. George W. Morrison is vice president and general manager, and was previously general superintendent for the Electric Alloy Steel Company.

The Rich Steel Products Company, Battle Creek, Mich., has tentative plans under advisement for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at close to \$125,000, including equipment. The reconstruction is estimated to cost approximately a like amount. Additional machinery will be installed.

The Dominion Alloy Steel Company, Toronto, Ont., recently organized by Michigan and Ohio interests, is perfecting plans for the erection of its proposed steel mill on tract of land acquired in the Indian Reserve section, fronting on the St. Clair River, near Sarnia, Ont., adjoining property now occupied by the Imperial Oil Company. The plant will consist of a number of operating units for the production of high-carbon and alloy steels, as well as kindred quality steel products. It will include a machine shop, power plant and other mechanical buildings and is estimated to cost close to \$3,000,000, with machinery. Financing for this amount has now been arranged. W. B. Boyd is president of the company; C. Harold Wills, of the Wills-Sainte Claire Motor Company, Maryville, Mich., is vice-president; and J. J. Mahon, consulting steel metallurgist. The board of directors will include Harry R. Jones, formerly head of the United Alloy Steel Corporation, Canton, Ohio.

The Baldwin Canadian Steel Corporation, Toronto, Ont., has tentative plans under advisement for extensions and improvements in its tin plate mill and works in the Ashbridges Bay section. It is proposed to remodel the existing plant to a considerable extent, with the installation of additional equipment in a number of departments. A total of eight furnaces and mills will be made ready for operation. It is expected to resume production at the plant early in the coming year.

The Cleveland Steel Tube Company, Miles Avenue and the Erie Railroad line, Cleveland, Ohio, has preliminary plans under way for a new addition, with improvements in the present works, estimated to cost in excess of \$150,000. Considerable additional machinery will be installed for

increased output. The enlargement will be commenced at an early date and pushed to completion. Jacob Stahler is president.

The Jones & Laughlin Steel Corporation, Pittsburgh, Pa., is said to be arranging preliminary plans for the construction of its proposed new steel mill on site acquired a number of months ago at Hammond, Ind. The company has awarded a general contract to the Great Lakes Dredge & Dock Company, Chicago, Ill., for the construction of about a mile of dock bulkheads at this location. The Indiana Harbor ship canal will be dredged, it is stated, to make way for the new mills. The bulkhead work alone, will cost in excess of \$200,000. The company's property approximates 1,000 acres of land. Contract has been awarded to the Minter Homes Company, Greenville, S. C., for the erection of about 100 houses at Woodlawn, Beaver County, Pa., in the vicinity of the company's plant at Alliquippa, Pa., to be used by employees at this works. Modern improvements will be installed in all of the homes.

The Elwood Ivens Tube Works, Inc., Oak Lane Station, Philadelphia, Pa., manufacturer of steel tubing and other steel products, has completed plans and will proceed with the erection of a new addition to its plant for general increase in output. It will be one-story, 175 x 200 feet, estimated to cost approximately \$50,000. A list of equipment and machinery to be installed has been arranged.

The Warren Steel Casting Company, 3400 Maury Avenue, St. Louis, Mo., has revised plans under way for the rebuilding of the portion of its plant destroyed by fire a number of months ago. The new structure will be one story, 60 x 200 feet, and is estimated to cost close to \$65,000, including equipment. Oliver J. Popp, Odd Fellows' Building, St. Louis, is architect. C. E. Hayden is president of the company.

The Bethlehem Steel Corporation, Bethlehem, Pa., has resumed operations at its rail department at the Sparrows Point, Baltimore, Md., mills, which has been closed for a number of months past. The rolling mill will give employment to more than 250 operatives, and it is expected to increase this number in the near future.

The Low Moor Iron Company, Low Moor, near Covington, Va., has blown in its No. 5 reserve furnace, idle since December, 1920, giving employment to about 125 men. Repairs are under way at other furnaces at the plant and the units are expected to be ready for service at an early date.

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